APR 7 1927

"THE ENGINEER," MARCH 25, 1927

With METALLURGICAL SUPPLEMENT.

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXLIII.—No. 3715] LONDON: FRIDAY EVENING, MARCH 25, 1927 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

For Sale, About 36 Tons of C.I. PIPES and SPECIALS, principally 14in., lying at a depot near Torpoint, Cornwall.

Full particulars and forms of Tender may be obtained from the SUPERINTENDING CIVIL ENGINEER, H.M. Dockyard, Devonport. 5045

Assistant Engineer ReQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officer appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25-30, must have passed the examination for A.M.I.C.E. or possess a degree in civil engineering recognised by the Institution as exempting from parts "A" and "B" of the examination. They should have preferably been trained in municipal engineering and possess experience in building and architectural work. Candidates possessing other civil engineering qualifications may apply.—Applications should be made at once by letter, stating age, qualifications and experience, also whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, mentioning this paper and quoting M/14485. 5058

The Government of BIHAR and ORISSA REQUIRE the SERVICES of an EXECUTIVE ENGINEER for the PUBLIC HEALTH DEPARTMENT (ENGINEERING BRANCH). Candidates must have had regular training as Civil Engineers and be either Associate Members of the Institution of Civil Engineers or hold equivalent professional qualifications. Seven years' good practical experience in England of the design and execution of waterworks and drainage is essential, and a general knowledge of mechanical and elementary electrical engineering is advantageous. Age 30 to 40 years.

Five years' agreement. Pay in accordance with an age scale, e.g., age 30, Rs. 725 a month plus overseas pay, £25 a month; age 40, Rs. 1175 a month plus overseas pay, £30 a month. Free first-class passage to India for self and wife and return passage on satisfactory termination of agreement. Provident Fund. Strict medical examination. (Overseas pay and return passage admissible only to an officer of non-Asiatic domicile.)

Further particulars and forms of application may be obtained (on request by post card) from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 14th April, 1927. 5074

The Institution of Chemical ENGINEERS.

EXAMINATIONS for the ASSOCIATE MEMBERSHIP of the INSTITUTION WILL BE HELD in JUNE and JULY NEXT.

Particulars of the examinations and the Memorandum on "The Training of a Chemical Engineer" may be obtained on application to the Hon. Registrar, C. S. GARLAND, Esq., the Institution of Chemical Engineers, Abbey House, Westminster, London, S.W. 1.

Applications for entry must be received not later than 1st May, 1927. 5066

The Institution of Structural ENGINEERS.

BRENFORCE TRAVELLING SCHOLARSHIP, VALUE £300.

The "Brenforce Travelling Scholarship" will be awarded triennially, including 1927. The Scholarship is awarded "with the object of encouraging the æsthetic design and artistic development in England of buildings in concrete and reinforced concrete." The competition will consist of a problem in design, conducted on Beaux Arts methods (i.e., a preliminary twelve-hour sketch design, of which a copy is lodged, followed by finished final designs from the sketch, for which 28 days is allowed). Preliminary competition on Saturday, 7th May. Candidates must be members (in any class) of the Institution, between the ages of 21 and 40 years. Winner receives £300 and gold medal. Closing date for entries, Monday, 2nd May. Syllabus and full particulars from the undersigned.

MAURICE G. KIDDY, F.I.S.A.,
Secretary of the Institution.
10, Upper Belgrave-street, S.W. 1,
21st March, 1927. 5059

Belper Waterworks.

CONTRACT NO. 3.

The Belper Urban Council invite TENDERS for the ERECTION of a STONE-BUILT PUMP HOUSE at their Waterworks, together with the FOUNDATIONS for PUMPING MACHINERY.

The drawings may be seen and copies of the specification and schedule of works may be obtained from the Engineer, Mr. F. W. Hodson, M. Inst. C.E., at Bank Chambers, Loughborough, on deposit of cheque for £5 5s., which will be refunded on receipt of a bona fide Tender and the return of the documents.

Tenders are to be sent to the undersigned not later than 23rd April, 1927.

The Council do not bind themselves to accept the lowest or any Tender.

Dated this 22nd day of March, 1927.

J. PERCY R. PYM,
Clerk to the Council.
5067

Bombay, Baroda and Central INDIA RAILWAY CO.

The Directors are prepared to receive up to Noon on Wednesday, 6th April, 1927, TENDERS for the SUPPLY of :—

1. WROUGHT IRON or MILD STEEL PIPING, &c.
2. LEATHER BELTING, &c.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.
Offices: 91, Petty France, Westminster, S.W. 1,
21st March, 1927. 5075

The Engineer

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PUBLIC NOTICES

The Madras and Southern MAHRATTA RAILWAY COMPANY, Limited, 25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for :—

ENGINE TURNTABLE (BROAD GAUGE), 85ft. Diameter.

Tenders are due in on Tuesday, 12th April, 1927, by 2 p.m.

Tender form obtainable at above address; fee One Guinea, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender. 5077

Metropolitan Water Board. PRIMARY FILTERS, KEMPTON PARK WORKS.

The Metropolitan Water Board invite TENDERS for the CONSTRUCTION of 24 REINFORCED CONCRETE PRIMARY RAPID FILTERS, each about 26ft. by 16ft. 6in., COMPRESSOR and PUMP HOUSE, WASH WATER TANK, SLUDGE BEDS, REINFORCED CONCRETE FILTERED WATER CULVERT, together with the LAYING of incidental MAINS and DRAINS, the CONSTRUCTION of ROADS and PATHS and ANCILLARY WORKS in connection therewith at Kempton Park, Hanworth, in the County of Middlesex.

The drawings and contract documents may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 291), on and after 21st March, 1927.

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities, may be obtained from the Chief Engineer on and after 28th March, 1927, on production of an official receipt for the sum of £10, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the "Metropolitan Water Board" and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Primary Filters, Kempton," must be delivered at the offices of the Board (Room 122) not later than 10 a.m. on Monday, 25th April, 1927.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.
Offices of the Board,
173, Rosebery-avenue, E.C. 1,
16th March, 1927. 5017

PUBLIC NOTICES

Metropolitan Water Board. MAINS—KEMPTON PARK PUMPING STATION.

The Metropolitan Water Board invite TENDERS for the LAYING and JOINTING of the undermentioned approximate LENGTHS of CAST IRON WATER MAIN and CONNECTIONS from and to the Filters, Pumps and Reservoirs at the Board's Works at Kempton Park, Hanworth, in the County of Middlesex, and across the Hanworth/Sunbury Road, together with the CONSTRUCTION of a CONCRETE SUCTION TANK and other contingent WORKS, namely :—

358	Lin. Yards of	60in.	diameter	Cast Iron Main,
983	do.	54in.	do.	do.
404	do.	48in.	do.	do.
317	do.	42in.	do.	do.
126	do.	36in.	do.	do.

The drawings and contract documents may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 201), on and after 28th March, 1927.

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities, may be obtained from the Chief Engineer on and after 4th April, 1927, on production of an official receipt for the sum of £10, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturdays, 10 a.m. and 12 noon). Cheque must be made payable to the "Metropolitan Water Board" and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Mains, Kempton Park Pumping Station," must be delivered at the offices of the Board (Room 122) not later than 10 a.m. on Monday, 25th April, 1927.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.
Offices of the Board,
173, Rosebery-avenue, E.C. 1,
16th March, 1927. 5018

THE STANTON IRONWORKS COMPANY, Limited, near Nottingham, REQUIRE the FULL-TIME SERVICES of a REPRESENTATIVE to keep touch between England and their Agents in each of the South American countries.—Apply in writing, in confidence, setting out previous experience, to the MANAGING DIRECTOR, c/o the above. 5069 a

PUBLIC NOTICES

Royal State Railways of Siam.

NOTICE.

Sealed TENDERS for the SUPPLY of BOGIES and UNDERFRAMES for BOGIE CARRIAGES, B.E. 2470, will be received by the Administration of the Royal State Railways of Siam, Bangkok, until Four o'clock on the 4th July, 1927, at which place and hour the Tenders will be publicly opened and read.

Blank Tender forms, general conditions, specifications and drawings may be obtained from Messrs. SANDBERG, 40, Grosvenor-gardens, London, S.W. 1, upon payment of £1 10s. per set, which sum will not be refunded.

Right is reserved to reject any or all Tenders, and to accept any Tender which is to the best interests of the Royal State Railways of Siam. 5068

South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. STRUCTURAL STEEL WORK.
2. POINTS and CROSSINGS (L.W.F.).
3. POINTS and CROSSINGS.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Structural Steel Work," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 8th April, 1927, for Specifications Nos. 2 and 3, and on Friday, 22nd April, for Specification No. 1.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of Specifications Nos. 1 and 2, and of 5s. for each copy of Specification No. 3.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.
91, Petty France, S.W. 1,
22nd March, 1927. 5071

Surrey County Council. HIGHWAYS AND BRIDGES DEPARTMENT.

The Surrey County Council invite TENDERS for :—

1. The RECONSTRUCTION of SIDLOW BRIDGES, situated on the Reigate-Hookwood Main Road (A.217), about 2 miles south of Reigate.
2. The WIDENING of NEW CHAPEL GREEN BRIDGE, situated on the London-Eastbourne Main Road (A.22), about 4 miles south of Godstone.

Copies of the forms of Tender, instructions to persons desirous of tendering and bills of quantites, may be obtained from the undersigned, and the forms of contract, general conditions, specifications and drawings may be examined at the office of the County Surveyor on weekdays (except Saturdays) from 10 a.m. to 4.30 p.m., on and after Tuesday, 22nd March, on payment of a deposit of £5 5s. for each bridge, which amount will be refunded upon the receipt of the above-mentioned documents complete with a bona fide Tender or Tenders. Each Tender must be enclosed in a sealed envelope, endorsed "Tender for Bridges," and lodged not later than 9 a.m on the 5th April, 1927

The Council does not bind itself to accept the lowest or any Tender.

W. P. ROBINSON, Assoc. M. Inst. C.E.,
County Surveyor.
Milner-road Annexe, Kingston-on-Thames,
16th March, 1927. 5020

For Sale, One Crompton Shunt-WOUND DYNAMO, 100 volts, 200 amps., direct coupled to 11in. by 6½in. double-crank Bumsted and Chandler Steam Engine, 32 B.H.P. at 400 rev. at 80 lb. pressure. Engine has extended shaft with pulley for driving other gear.

Also CROMPTON SWITCHBOARD and D.P STORAGE BATTERY, 800 amps-hrs. in glass boxes.

May be seen at Ham Green Hospital, Pill, near Bristol. Purchaser would have to dismantle and cart same away. The dismantling to be carried out during the normal working hours of the hospital.

Offers to be made, in writing, to the MEDICAL OFFICER OF HEALTH, 40, Prince-street, Bristol. 5042

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PUBLIC NOTICES

Administrative County of LONDON.

The London County Council invites APPLICATIONS for the undermentioned TECHNICAL APPOINTMENTS in the Chief Engineer's Department: ONE POSITION of SENIOR ASSISTANT, £360, rising by £20 annually to £400 a year, thence by £25 annually to £450 a year; FIVE in the FIRST CLASS, £250, rising by £15 annually to £310 a year, thence by £20 annually to £350 a year; and FOUR in the SECOND CLASS, £120, rising by £10 annually to £150 a year, and thence by £15 annually to £240 a year. There are prospects of promotion. The salaries are based on pre-war conditions and are at present subject to temporary additions on the Civil Service scale, fluctuating according to the cost of living. On the existing basis the total remuneration represented by the minima and maxima is as follows:—Senior Assistant, £517 9s. 9d. and £632 7s. 8d. a year; First Class, £377 and £504 13s. 10d. a year; Second Class, £203 12s. 4d. and £364 4s. 7d. a year. The next revision of the temporary additions will take place not later than 1st September, 1927.

Candidates must either (A) be Corporate Members of the Institution of Civil Engineers, or (B) have passed Sections A and B of the Associate Membership Examination of the Institution of Civil Engineers or taken a degree recognised by the Institution as exempting therefrom. They must have had experience of the design and construction of civil engineering works. There are no vacancies for candidates whose training has been on the mechanical or electrical side. Due weight will be given to the claims of those applicants who served or attempted to serve with H.M. Forces. Candidates who did not so serve must be natural-born British subjects, and those not already in the Council's service must be under 40 years of age on 12th April, 1927. This age limit, however, will not operate to render ineligible any candidate who in June, 1926, in response to public advertisement, submitted an application in respect of first and second-class positions in the Chief Engineer's Department and was under 40 years of age on 23rd June, 1926.

Applications must be made on the official form, copies of which (with full particulars) may be obtained by sending a stamped addressed foolscap envelope (marked "Technical Assistants") to the Clerk of the Council, The County Hall, Westminster Bridge, S.E. 1.

Forms must be returned by 12th April, 1927. Canvassing disqualifies.

MONTAGU H. COX,
5048 Clerk of the London County Council.

Borough of Guildford.

CLERK OF WORKS.

The Corporation invite APPLICATIONS for the APPOINTMENT of CLERK OF WORKS in connection with a Contract for the Erection of Two Reinforced Concrete Service Reservoirs to contain 1 million gallons and 500,000 gallons respectively and the Laying of 1 Mile of 6in. Water Main.

Applications, stating the age of the candidate, must be accompanied by copies of at least three recent testimonials, and full details of the candidate's practical experience in the construction of reinforced concrete structures for waterworks, and must be sent by post to the Consulting Engineer, Mr. Percy Griffith, 39, Victoria-street, S.W. 1, not later than the 8th of April, 1927.

The appointment will be for the period required for the completion of the works; salary £6 6s. per week.

C. H. WOOD,
Town Clerk.

Town Clerk's Office, Guildford,
24th March, 1927. 5080

Greenwich and Deptford Institution AND HOSPITAL, WOOLWICH-ROAD, GREENWICH.

The Guardians invite APPLICATIONS for the APPOINTMENT of CHIEF ENGINEER for the above establishments. Two Assistants are employed. Candidates must be fully experienced in the maintenance of Lancashire Boilers, Steam Heating, Laundry Plants, Electric Light Installation and A.C. Motors.

Salary £312 per annum, increasing £26 per annum to £364. Deductions are made from salary under the Poor Law Officers' Superannuation Act, 1896.

Applications are to be made upon forms obtainable from the undersigned and returned duly completed to the Guardians' Offices, Woolwich-road, East Greenwich, not later than 21st April, 1927.

By Order,
W. C. CORNISH,
Clerk to the Guardians.

March, 1927. 5047

Municipality of Singapore,

STRAITS SETTLEMENTS.
WATER DEPARTMENT.
APPOINTMENT OF ASSISTANT WATER ENGINEER.
ADVERTISEMENT.

The Municipal Commissioners of Singapore RE QUIRE an ASSISTANT ENGINEER for their Water Department, age 21 to 25 years, unmarried, on a three years' agreement, with possible extension.

Applicants must possess a recognised University Degree in Civil Engineering, or must have passed Sections A and B of the Associate Membership Examination of the Institution of Civil Engineers.

Applicants must have served articles or gained experience under a qualified engineer, preferably one engaged in waterworks practice.

Salary 5400 dollars for the first year, 5700 dollars for the second year, and 6000 dollars for the third year, payable monthly in Straits currency. The value of the dollar is 2s. 4d. sterling, and the pay of the appointment for the first year is therefore £630. An allowance for transport when on duty will be granted. Free passage will be provided with half-pay during the voyage out. The selected candidate must pass an approved medical examination.

Applications, stating whether married or single, age, birthplace, and giving details of education, training and experience generally, with particular reference to the qualifications mentioned above, and accompanied by copies (not originals) of testimonials, to be lodged with Messrs. PEIRCE and WILLIAMS, MM. Inst. C.E., 64, Victoria-street, London, S.W. 1. Agents for the Commissioners, not later than Thursday, 31st March, 1927.

Further particulars, if desired, can be obtained from the Agents. 5056

Municipality of George Town,

PENANG, STRAITS SETTLEMENTS.
MUNICIPAL ENGINEER'S DEPARTMENT.
APPOINTMENT OF ASSISTANT ENGINEER.
ADVERTISEMENT.

The Municipal Commissioners of George Town, Penang, REQUIRE an ASSISTANT ENGINEER, aged 23 to 30 years, unmarried, on a three years' agreement, with possible extension.

Applicants must have had a good technical education and regular training as pupil and assistant, preferably in a Municipal or County Engineer's Office, and must possess experience in Municipal and General Engineering, Roads, Buildings, Bridges, Sewerage and Conservancy Work, and the Control of Workmen.

Candidates must be Corporate Members of the Institution of Civil Engineers and preference will be given to those who have passed the Testamur Examination of the Institution of Municipal and County Engineers.

Salary 5400 dollars for the first year, 5700 dollars for the second year, and 6000 dollars for the third year of the agreement.

Salary will be paid monthly in dollars, the currency of the Colony, the value of the dollar being 2s. 4d. sterling. In addition, there is at present a temporary allowance of 10 per cent. on the salary for unmarried men, but this allowance is subject to revision or cancellation at any time. The pay of the appointment at the above rate for the first year, including the temporary allowance, would be £693. An allowance for the maintenance of a motor car when on duty will be granted. Free passage will be provided, with half-pay during the voyage out. The selected candidate must pass an approved medical examination.

Applications, stating whether married or single, age, birthplace, and giving details of education, training and experience generally, with particular reference to the qualifications mentioned above, and accompanied by copies (not originals) of testimonials, to be lodged with Messrs. PEIRCE and WILLIAMS, MM. Inst. C.E., 64 Victoria-street, London, S.W. 1, Agents for the Commissioners, not later than Thursday, 31st March, 1927.

Further particulars, if desired, can be obtained from the Agents. 5055

PUBLIC NOTICES

The South Metropolitan Gas COMPANY

has a VACANCY on its Constructional Staff for an ENGINEER.

The duties will be wholly those pertaining to the design and erection of new and remodelling of old plant. Experience in the conduct of a gas undertaking would be helpful and a sound scientific education is indispensable.

Salary £1000 per annum.

Applications to be addressed to the undersigned.

By Order.
FRANK DAY,
Secretary.

709, Old Kent Road, London, S.E. 15.
6th March, 1927. 5008

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED for Engineering Works in India, a WORKS MANAGER, who should be thoroughly well trained as a Mechanical Engineer, up to date in Machine Shop, Forge and Foundry Practice, capable of Designing Jigs and Tools for repetition work; must have had previous experience in India, and knowledge of Hindustani and Bengali, and conversant with modern costing systems and workshop accounts.—Address, 5054, The Engineer Office. 5054 A

WANTED, JUNIOR ASSISTANT CIVIL ENGINEER for West of England.—Address, stating salary required and qualifications, 5051, The Engineer Office. 5051 A

WANTED, JUNIOR ASSISTANT ENGINEER for West of England.—Address, stating qualification, age, and salary required, 5023, The Engineer Office. 5023 A

ASSISTANT ENGINEER REQUIRED for London firm; general engineering training, including Hydraulics; Drawing-office, business experience and sound education essential; must be accustomed to interview clients and thoroughly energetic and alert. Age about 30. Commencing salary £350, with good prospects for suitable man.—Full particulars, with copies of testimonials, to Box F.M. 26, Scripps's Advertising Offices, South Molton-street, W. 1. P2971 A

ENGINEER (Age 23/30), Public School and University (essential), single, to JOIN STAFF of WORKS near Manchester.—Apply in writing, GRAHAM, 20, Cooper-street, Manchester. 5061 A

ENGINEER, Single, Age 22 to 26, WANTED for Sumatra. Experience General and Structural Erection. Must be capable of installing and maintaining Electrical Machinery. Commencing salary £400 per annum.—Write, giving full particulars of experience, to Box 202, c/o Judd's, 47, Gresham-st., E.C. 2. 5081 A

ENGINEER WANTED, Age 25 to 30, Experience in Testing Portland Cements and Concrete; some Chemical Knowledge of Building Materials an advantage; must also be able to take out quantities and make drawings.—Address, 5064, The Engineer Office. 5064 A

ESTIMATOR and TECHNICAL ASSISTANT REQUIRED for large well-known Firm of General Ironfounders and Engineers. Splendid prospects and good salary to tip-top man with experience in Heavy and Light Castings and all classes of Machining, able to prepare estimates at competitive prices without supervision.—Address, stating age, experience, and salary, 4931, The Engineer Office. 4931 A

LARGE ENGINEERING WORKS in North of England REQUIRES RESEARCH ASSISTANT for Electrical Work, possessing Honours Degree in Physics. Previous practical experience not essential. State age, salary, experience, &c.—Address, 5041, The Engineer Office. 5041 A

REPRESENTATIVE REQUIRED, having Connection with Power Station Engineers and preferably with engineering training. The post holds out considerable prospects, and applications are invited from gentlemen with the connection desired and who can show proof of selling ability.—Address, P2969, The Engineer Office. P2969 A

REPRESENTATIVES.—REQUIRED for Several areas by well-known engineering firm, first-class MEN to sell High-speed Steam, Gas and Oil Engines, Compressors, Turbines, Condensers, &c. Candidates should be of good bearing, education and experience. Give extent of connection, experience and training, and state age and salary expected.—Address, 5050, The Engineer Office. 5050 A

SPANISH ENGINEER REQUIRED for Occasional Technical Translations into Spanish.—Write fully to P2970, The Engineer Office. P2970 A

SALESMAN/MANAGER for MOTOR CAR DEPARTMENT WANTED for service with old-established British Merchant Firm operating in the Middle East. Only candidates who can produce first-class references as to education, integrity, salesmanship, organising ability and who have had sound commercial and workshop training need apply. One with overseas experience preferred. Age about 30. Commencing salary, £800 per annum. First-class passage. Four years' agreement.—Write fully, with copies references, to H. B., 64, Cannon-street, London, E.C. 4. 5040 A

CHIEF DRAUGHTSMAN WANTED for Large General Engineering Works, dealing with a varied range of products in the Eastern Counties; must be a good organiser, have had a sound theoretical and practical training, and be able to design for the most economical production. Those applicants only will be considered who have held similar appointments.—Address, giving full particulars of experience, qualifications and salary required, 5044, The Engineer Office. 5044 A

DRAUGHTSMAN Experienced in the Lay-out and Design of Chassis and all Components.—Reply, stating age, experience and salary, to TILLING-STEVENS MOTORS, Ltd., Maidstone. 5062 A

DRAUGHTSMAN REQUIRED Temporarily. One experienced in Mechanical Detail Work Design on Compressors essential.—Address, stating age, experience and salary required, 4995, The Engineer Office. 4995 A

DRAUGHTSMAN, Single, Age 22 to 25, WANTED for Sumatra. General Engineering experience and familiar with design and construction of Structural Steel Work. Commencing salary £400 per annum.—Write, giving full particulars of experience, to Box 203, c/o Judd's, 47, Gresham-st., E.C. 2. 5082 A

DRAUGHTSMAN WANTED, with Good Technical and practical knowledge of Water-tube Boilers and Superheaters, costing experience also desirable.—Apply by letter, stating age, experience, and salary required, H. and T. DANKS (NETHERTON), Ltd., Dudley. 5085 A

EXPERIENCED DRAUGHTSMAN REQUIRED for temporary positions; accustomed to the Designing of Girder Work and other Constructional Work, Measuring-up Existing Bridges, Calculation of Stresses, &c.—Apply by letter to the DIVISIONAL ENGINEER, Engineer's Office, L.M. and S. Rly., Crewe, stating age, experience and salary required. 5063 A

SITUATIONS OPEN (continued)

EXPERIENCED LOCOMOTIVE DRAUGHTSMAN for Works in Lancashire.—Address in confidence, stating age, experience, and salary required, 5030, The Engineer Office. 5030 A

MATHER and PLATT REQUIRE a SENIOR DRAUGHTSMAN with experience in Centrifugal Pump design.—State age, experience, and salary, and address application to EMPLOYMENT DEPARTMENT, Park Works, Manchester. 5083 A

MESSRS. NEWTON, CHAMBERS and CO., Ltd., Thorncliffe Ironworks, near Sheffield, RE-QUIRE the SERVICES of a responsible DRAUGHTSMAN with experience in Gas and Chemical Works Plant.

Applicants are requested to state their qualifications, age, experience, salary required, and date duties could be began after appointment. Company's house available for successful applicant. 5070 A

SMART DRAUGHTSMAN, with Technical Training, preferably with some experience in Dairy Machinery, for a firm in S.W. London. Progressive position to a reliable man.—Address, P2973, The Engineer Office. P2973 A

STRUCTURAL DRAUGHTSMAN REQUIRED by British Firm in India. Must have had good technical training, be able to work out stresses, prepare designs, estimates, and detail drawings of Roof, Bridge and General Structural Steel Work. Must be a bachelor, age 22 to 25.—Apply, stating age and particulars of experience, to Z.8. 891, care Deacon's Advertising Agency, Fenchurch-avenue, London, E.C.3. 5072 A

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

The Launch of H.M.A.S. Australia.

ON Thursday of last week, March 17th, there was successfully launched from the Clydebank Yard of John Brown and Co., Ltd., the cruiser Australia, which is the first of the two light cruisers which the firm is constructing for the Commonwealth Government. Her sister vessel, the Canberra, is still on the stocks. She is in a well-advanced condition and it will not be very long before she, too, is ready to take the water. It will be recalled that the first Australia was also built at Clydebank, being launched in 1911, and that as a battle-cruiser she performed honourable service in the war. The new Australia was ordered in 1925, and in dimensions and power is generally similar to the light cruisers of the "County" class, which are now being built for the Admiralty. Her displacement is 10,000 tons and with machinery of 90,000 S.H.P. she is expected to have a speed of between 31 and 32 knots. The propelling machinery consists of a four-screw arrangement of Brown-Curtis geared turbines, steam being raised in oil-fired Yarrow water-tube boilers. In conformity with the limitations in armament imposed by the Washington agreement, she will carry eight 8in. guns and four 4in. high-angle guns, which will be supplemented by deck torpedo tubes. The Australia was named by Lady Cook, the wife of Sir Joseph Cook, the High Commissioner for Australia.

London's Electricity Supply.

A RECENTLY issued return relating to electricity supply in the London and Home Counties electricity district, contains some interesting information. For statistics relating to local undertakings the period covered is the year ending March 31st, 1925, and for statistics relating to company undertakings, December 1st, 1924. An appendix contains statistics of company undertakings for the year ending December 31st, 1925. The return shows that there is an increasing demand for current throughout the district, and that there is a tendency towards lower charges per unit. The area of the district is 1797 square miles, the number of authorised distributors within the district being 89, of which 44 are local authorities and 45 are companies. There are also two bulk supply companies. The total load in kilowatts for the district was 843,517, an increase of 11·7 per cent. over that for the previous year. The largest generating plants in December 31st, 1925, were those of the London Electric Supply Corporation, which had a plant of 86,200 kilowatts capacity, and the County of London Electric Supply Company, the capacity of the plant in its case being 79,725 kilowatts. Since that date additional plant has been installed, and the Barking Station of the County of London Electricity Supply Company has at present a generating capacity of 94,000 kilowatts. The two largest municipal undertakings are those of St. Marylebone, with a capacity of 45,500 kilowatts, and West Ham, having a plant capable of developing 37,000 kilowatts. During the year 1924–1925, the units sold in the district amounted to 965,000,000 compared with 845,000,000 in 1923–24, and 728,000,000 in 1922–1923. Nearly all the undertakings recorded substantially increasing demands for current. Interconnection is progressing rapidly, and bulk purchasing and sales of current are steadily increasing in number. Most of the smaller undertakings, and especially the extra-London company undertakings, now purchase current in bulk from the large undertakings, and have ceased to generate their own current.

The French Navy.

THE appeal of President Coolidge to the French Government to be represented, even unofficially, at the proposed conference to consider a further reduction of naval armaments has been followed by a good deal of publicity concerning the minimum naval strength necessary to ensure the protection of France. Monsieur Robaglia, who prepared the report upon the Naval Statute, which provided for a continuance of the programme of naval construction, affirms that the French Navy must be sufficiently strong to guarantee a free communication between North Africa and France, to ensure coast defence and the protection of the Colonies and to co-operate in the patrol of sea routes. There can be no question, it is argued, of France being dependent on other countries for the carrying out of these necessary duties. The programme now being carried out was carefully prepared in view of these minimum requirements, which provide for 390,000 tons of surface craft, comprising 210,000 tons of cruisers and 180,000 tons of destroyers and torpedo boats, and 96,000 tons of submarines. Monsieur Robaglia affirms that this fleet is very moderate for the duty it has to perform, and that France is certainly unable to accept anything less. The opposition of the French to any reduction of naval strength, unless it is accompanied by a general limitation of naval and military forces under conditions which render it very difficult of realisation, is strengthened by the feeling that France came out belittled at the last Washington Conference, and although her quota of battleship tonnage does not affect the naval situation, in view of the fact that battleships are, for the moment at any rate, outside the scope of French naval strategy, our neighbours are determined that no restrictions shall be placed upon the lighter surface craft and submarines unless they are assured that there can be no risk of foreign attack.

The Fleetwood-Belfast Steamers.

IN our issue of March 11th we referred in a Journal note to the proposal of the London, Midland and Scottish Railway Company to concentrate its Belfast steamer services at the port of Heysham. In confirming this proposal, the railway company states that it has been found necessary to provide a much larger and improved type of steamer for its Belfast services, which will be fitted with all the most modern conveniences, including single-berth cabins. With such steamers, questions of berthing and navigation had to be considered. The access to the sea from Heysham is easier than that from Fleetwood. Moreover, at the former port there is a large area of land which is available for expansion. It is stated that as far as train facilities are concerned, arrangements will be made to render the difference in the length of journey from the principal passenger centres a negligible one, while the transfer will involve no difference in the charges for either passenger or goods traffic to or from Belfast and beyond. In the opinion of the company, the proposed change will increase the effectiveness of the Belfast service and room will be left for the future expansion of the Fleetwood fish trade and the general mercantile business of that port. Three new steamers for the service above referred to have been ordered by the London, Midland and Scottish Railway Company from William Denny and Brothers, Ltd., of Dumbarton. They will be twin-screw vessels propelled by geared turbines, and designed for a speed of 21 knots. The overall length will be 360ft., and the beam some 12ft. more than the existing Fleetwood boats. A feature of the design will be the provision for 150 single-berth cabins, as well as suites *de luxe* and state rooms. The new steamers will have a cargo-capacity of about 500 tons.

Phosphate Loading Plant in the South Pacific.

WE learn that the British Phosphate Commissioners have placed an order with Henry Simon, Ltd., Manchester, for very extensive ship loading plant and handling and storage equipment for dealing with the deposits of phosphate of lime which are to be found on the island of Nauru and on Ocean Island in the South Pacific. The extent of the deposits available on the two islands is estimated at about one hundred million tons. The two islands formerly belonged to Germany, but were taken over by Great Britain during the war. Nauru, which lies right on the Equator, 500 miles N.N.E. of the Solomon Islands and about 2000 miles from Sydney, Australia, is only six miles long and four miles wide, and Ocean Island, 165 miles east of Nauru, is even smaller. These islands are of coral limestone formation, a deep stratum of which has been phosphatised by the action of the weather on deposits of guano, and has been rendered a particularly valuable fertiliser. The great difficulty experienced has been to load the phosphate to ships, owing to the fact that there are no harbours. In addition, there is a shelving beach which runs out several hundreds of feet and which even at high tide is covered by only very shallow water. The ships have to lie off the shore for loading purposes and steam has to be kept up all the time so that they can be moved quickly out to sea in case of a sudden squall. In order to improve the loading facilities and to increase the rate at which the phosphate can be handled, Messrs. Simon are to install up-to-date mechanical loading plant on both islands. The bulk of the work is to be done at Nauru, where mechanical conveyors are to be erected to bring the phosphate from the quarries to the shore, and a storage building capable of holding 12,000 tons of the material is to be erected. The phosphate will be loaded direct to ships by means of two huge swinging cantilever arms reaching out 200ft. over the sea. Each cantilever will carry a loading-out conveyor and will be capable of handling 300 tons of phosphate per hour. At Ocean Island a considerable amount of plant is already in existence, and a new handling plant and a big loading jetty, 350ft. long, are to be provided to work in conjunction with the existing mechanical conveyors.

Chilean Destroyer Contract.

THE contract for the six Chilean destroyers, tenders for which were submitted some months ago by many firms in this country and on the Continent, has been awarded to J. I. Thornycroft and Co., Ltd., of Woolston. The senior officer of the Chilean Naval Mission is now on his way to England in connection with this order. Tenders were submitted by twelve British firms, two French, three Italian, one Spanish and one Dutch firm. We understand that the keenest competition came from Italian firms, but there is little doubt that the final decision of the Chilean Government was influenced by its knowledge of the unequalled experience of destroyer construction which British shipbuilders possess. Although particulars of the contract are not yet available, the vessels in question are believed to be above the average displacement of their type. The laying-down of six destroyers will provide employment for a large number of men at Messrs. Thornycroft's Woolston yard, where naval work has been scanty since the completion of H.M.S. Amazon, now concluding her steam trials. They represent by far the most important naval contract from abroad which British industry has secured since 1914, and the fact that a British firm has been successful justifies a hope that further naval orders from South America, which are reported to be impending, will come to this country. Five large destroyers now under the Chilean flag were built by J. Samuel White and Co., of Cowes. Three of these were taken over by the British Navy on the outbreak of war, and re-purchased by Chili in 1920. They are boats of 1730 tons, and at the date of completion were the most powerful torpedo craft afloat. All the other ships of the present Chilean fleet, excepting only an obsolete coast-defence battleship and six submarines, were built in British yards.

A Kent Colliery to Close.

AFTER spending a considerable time in inquiring into and hearing objections to the proposal of the Tilmanstone (Kent) Collieries to erect an aerial ropeway for conveying coal from Tilmanstone to Dover, a distance of 6½ miles, the Railway and Canal Commission last week gave its judgment against the scheme. Almost immediately afterwards the colliery company issued notices to its 900 workmen to cease work in fourteen days' time. This action on the part of the colliery, an official announcement states, has been dictated by the fact that without the ropeway the colliery cannot be kept in profitable working. During the first week of March the colliery produced 4085 tons of coal at a cost of 17s. 2½d. per ton, excluding interest and depreciation charges. The average selling price for that week was 14s. 4½d. During the last week of February the output was 9206 tons, the cost 15s. 3½d., and the selling price 13s. 8½d. per ton. Coal has been worked at Tilmanstone since 1907. In 1925 the present company leased the undertaking from the East Kent Colliery Company for sixty-five years. A million pounds of capital have been sunk in the pit, and within the past six months £100,000 have been spent on the installation of improved pumping and other equipment. Additional expenditure, amounting to £625,000, was also contemplated in the near future. It was the management's object to raise the output to 4000 tons a day, a step which it was hoped would reduce the cost of production to 12s. to 13s. per ton. To dispose of that output it was held to be essential to seek export markets instead of, as previously, relying on the local demand. Such a step demanded, in the company's opinion, the erection of an aerial ropeway from the colliery to the port of Dover. The existing system of railway transport was held to be unsatisfactory, on account of its cost and its liability to interruption. With the refusal of the Commission to permit the erection of the ropeway, the company finds itself in a position which, it holds, does not permit it to continue operations with any profit.

The British Electrical and Allied Manufacturers' Association.

THE statutory annual general meeting of the British Electrical and Allied Manufacturers' Association took place a few days ago, when Colonel R. K. Morcom, chairman of the Council, delivered an interesting speech on the Electrical Industry in 1926. In spite of all obstacles, he said, the British electrical industry had been able to maintain its position of leading supplier of electrical goods abroad. Compared with Germany, the United States and Switzerland, this country had moved much more rapidly since 1913, and had strengthened its hold on overseas markets. In seven years British manufacturers had supplied generating plant aggregating almost 2,000,000 kilowatts, and the results obtained from that plant had created a tradition of high operating efficiency which had penetrated to every part of the world. In traction, in control and switchgear and transformers, the same record had been achieved, and the electrical industry, with exports totalling £18,194,000 in 1926, took first place among the engineering exporting industries of the country. Competition in 1926 was felt most in South America and Australia, and in both countries the United States provided the main opposition. With the possible exception of Australia, which was still supporting the United States products, the British manufacturer was actually able to improve his position in almost every market. In Brazil, in Argentina, in Chili, in Japan, and even in Canada, the relative position occupied by Britain showed a considerable improvement. Owing to improvement in the monetary situation, trade was being resumed with the continental countries, and important orders, which would have otherwise gone to Germany or the United States, were secured.

The World's Future Supplies of Liquid Fuels.

By JOHN B. C. KERSHAW, F.I.C., F.S.S.

No. IV.*

THE PRODUCTION OF METHANOL AND OTHER ALCOHOLS FROM COAL.

Methanol is now generally accepted as the scientific and trade name for wood spirit or methyl alcohol, the first member of the very important series of alcohols based on the paraffin series of hydrocarbons. The group of processes which are now to be described for the synthetic production of methanol, and the higher members of the series, start, like the Bergius process, with coal as their raw material; but the coal is gasified before submitting to catalytic hydrogenation, and the processes differ therefore essentially from the Bergius process. It is true that the use of a gas instead of a solid material, overcomes some of the difficulties, especially those due to the presence of ash; but, on the other hand, the use of a catalyst introduces other difficulties in the conduct of the process, and there is also some loss of the carbonaceous material and of heat, owing to the gasification of the solid fuel as a preliminary to the hydrogenation process.

It is, therefore, still too soon to decide which type of process will be the more successful in meeting the world's future needs of liquid fuels, and only time and experience will decide which will be the survivor.

Three processes of catalytic hydrogenation of carbon monoxide, or of gases containing that gas, have now reached the industrial stage of their development, namely, the German Badische Aniline and Soda Fabrik process, the French Patart and Audibert processes, and the German Fischer and Tropsche process.

The Badische Process.

The Badische A. and S. Fabrik process is the result of experimental work begun by the chemists of that company one year before the outbreak of war in 1914. There is little doubt that the industrial development of the process would have occurred much earlier had it not been for the subsequent interruption and delays. The first successful experiments, on a semi-industrial scale, with the Badische process, however, were not made until four years after the close of the war, and the first English patent, granted to the Badische Company, is No. 229,715 of February, 1925, but with an application date of August, 1923. The two principal claims from this patent are reproduced below:—

(1) The process of synthetically manufacturing methanol or products substantially consisting of methanol by catalytically reducing carbon monoxide or dioxide at elevated temperatures and pressures which is characterised by the use of contact masses, containing besides one or more of the following elements—copper, silver, gold, zinc, cadmium and lead; also titanium, vanadium, chromium, manganese and other cognate elements related to them, namely, zirconium, cerium, thorium, niobium, tantalum, molybdenum, tungsten, uranium or boron, or more than one of these elements or compounds thereof, and preferably also using such gas mixtures as contain more hydrogen, by volume, than carbon oxides, which gas mixtures should be used in any case when mixtures of zinc, with oxides of chromium, manganese, molybdenum, titanium or cerium are used as catalysts.

(2) In the process of manufacturing methanol, according to Claim (1) the use of catalysts of the kind described which are free from alkali compounds and from iron and nickel.

The Badische Company has not yet published any details of its methods of operation beyond those given in the patent specification, but Elworthy has contributed an interesting article to *Canadian Chemistry and Metallurgy* on the process, and has made public some interesting particulars concerning its operation. Purified water gas, having approximately a composition of 60 per cent. hydrogen and 30 per cent. of carbon monoxide is passed over the catalyst at a pressure of 200 atmospheres, and at a temperature of about 400 deg. Cent., the type of apparatus employed being similar to that used for the Haber process of ammonia production. The reaction between the gases results in the formation of a mixture of watery and oily liquids, from which pure methanol can be separated by fractional distillation. The catalysts employed are mixtures of oxides of metals belonging to different groups of the Periodic Table, the examples given in the patent specification being:—

(1) 90 parts zinc oxide, with 10 parts chromic oxide.
(2) 85 „ „ „ 15 „ vanadium oxide.
(3) 90 „ cadmium oxide, with 10 parts chromic oxide.

The gases must be carefully purified before submitting to the catalyst, and must be free especially from sulphur and from volatile compounds of iron. In order to effect this purification, activated carbon, soda lime or hot caustic alkali are employed to convert the sulphur compounds into a form in which they can be removed from the gases; while the iron compounds, such as iron carbonyl, are destroyed by passing the gases over hot copper or over copper mixed with a catalyst.

From the information which has been published in the various patents, and in other contributions relating to the synthesis, one learns that the following conditions are essential for the production of methanol:—

(1) There must be at least two volumes of hydrogen to one of carbon monoxide present in the gas mixture.

(2) The catalyst must consist chiefly of oxide of zinc, with oxide of chromium and metallic copper, or copper oxide as the other constituent; and there must be a complete absence of alkali from the mixture.

(3) The apparatus employed should be constructed of alloy steel, lined with copper, aluminium or zinc, and capable of standing a pressure of at least 250 atmospheres, at the temperature employed. The apparatus should contain a heating element which will raise the temperature of the incoming gases to 250 deg. Cent. or 300 deg. Cent. before they come into contact with the catalyst, and it is essential that the gases should be preserved from any contact with iron, nickel or cobalt during that stage of the process.

(4) Only a portion of the gas employed enters into the reaction at each passage over the catalyst, and the residual gas after being brought up again to the proper degree of concentration by mixing with hydrogen and carbon monoxide, is re-circulated through the apparatus.

Lormand, who has made a special study of the Badische process, states that the synthesis of methanol on a commercial scale is less difficult than that of ammonia, since it is not necessary to employ absolutely pure gases, and standard forms of compression apparatus with reaction chambers having a capacity of 20 tons per day may be used. The following estimate has been given by him for the cost of operating a plant producing 7½ tons of methanol per day, or 852,000 gallons per annum:—

	Francs.
150 cubic metres of water gas, at ·16f. per c.m.	24·0
67 cubic metres of hydrogen, at ·25f. per c.m.	16·0
Operating and interest charges	65·0
Total cost	105·0

This cost is per hectolitre, or 22 gallons, and represents 18 cents per gallon at the present rate of exchange.

With regard to the actual development, the Badische process has advanced further industrially than the Bergius process, since the Badische Company has been manufacturing methanol at its Merseberg (Saxony) plant at the rate of 20 tons per day since early in 1925. Last year two units of plant were put into operation at the Oppau and Ludwigshafen works, which, it is stated, have increased their output of synthetic wood spirit to 25,000 tons per annum.

The economic effect of the new process has been most marked in America, for in that country the wood distillation industry has been developed upon a very large scale, and has supplied quite one-half of the world's consumption of wood alcohol, and of formic and acetic acids. The current American price for wood alcohol is now 80 to 85 cents per gallon, and the margin for profit on the synthetic product is remarkably high and is more than sufficient to cover the cost of transport across the Atlantic. According to Wooton, however, the larger proportion of the German output of synthetic methanol is now employed by the Badische Company in its own works for the manufacture of dyes and resins, and no attempt is being made at present to push the sale of the synthetic product in the home or in foreign markets. Arrangements, in fact, have been entered into with the combine which controls the wood distillation industry in Germany to postpone the date of open competition between the natural and the synthetic products, and a similar arrangement has possibly been made with the American producers of wood spirit.

It is expected, however, that the foreign rights of the Badische process will be sold in America at an early date, and that the synthetic process of manufacture will be started in that country before any legislation for increase of the duty on the imported spirit can be passed.

Before passing on to a description of the French processes for the production of methanol, it may be stated that the position with regard to the priority of the French and German processes is somewhat confused, and that there is now considerable doubt as to whether the Badische patent claims in foreign countries can be maintained. The issues of the German *Chemiker Zeitung* in May and July, 1925, contained some correspondence on this subject between the Badische Company and Monsieur Patart, which should be studied by all chemists and engineers interested in the future of the synthetic processes.

In the issue of May 30th the Badische Company referred to the "mis-statements" which had been made by Monsieur Patart, in a lecture delivered in Paris earlier in 1925. The assertions made were answered by Monsieur Patart in the issue of July 7th, and an opinion of Dr. F. Fischer was quoted, which seems to dispose of the Badische claims, for this authority had stated publicly that the delay in the development of the Badische process as originally patented was due to the fact that it would not yield a satisfactory or saleable product.

F. J. Lush, who is one of the leading authorities in this country on the subject of catalytic hydrogenation processes, has also delivered an opinion upon this question of patent priority, and has stated that the method of producing methanol by catalytic hydrogenation of carbon monoxide was first described in a patent granted to his own firm, the Technical Research Works, Ltd., of London. This patent, No. 180,016 of 1921, was granted six months earlier than Patart's patent No. 540,343; while the Badische Company's first English patent, No. 229,715, as already stated, was not granted until February, 1925, although the application date was August, 1923. These dates appear to prove conclusively the priority of the Technical Research Works' patent in the United Kingdom.

Lush considers that the catalytic hydrogenation of gas mixtures containing carbon monoxide and hydrogen has a great future, since by aid of a controlled and preliminary condensation of the carbon monoxide gas, the synthetic manufacture of any desired alcohol of the series $C_nH_{2n+2}O$ will be possible, and the character of the product finally obtained can be determined by the iron or nickel carbonyls, formed during the first stage of the process. By avoiding the presence of iron and by employing copper to decompose the nickel carbonyl, the condensation of the carbon monoxide can be prevented, and intermediate products, such as methanol and formaldehyde can be produced.

Two French Processes for the Synthetic Production of Methanol.

Monsieur Patart is Inspector-General of the French Bureau of Explosives, and was in charge of the first plant erected in France after the war for the production of synthetic ammonia by the Haber process. This plant was erected at Toulouse, and is operated as a subsidiary of the Government Powder Works at that place. As a result of the knowledge and experience gained in the erection and management of this plant, Monsieur Patart was led to investigate the possibility of applying high pressures to the synthetic production of methanol, from mixtures of carbon monoxide and hydrogen gas. He began his experimental work on this new synthesis in 1921, and his first patent, No. 540,343, is dated August of that year. In this patent Patart claimed as catalytic agents for the process all metals, their oxides and their salts, which were known to favour hydrogenation, and temperatures ranging from 300 deg. to 400 deg. Cent., with pressures from 150 to 200 atmospheres, were named as the limits within which the synthesis could be carried out.

A gas mixture containing two volumes of hydrogen to one of carbon monoxide was specified in the patent, and in order to avoid decomposition of the methanol produced by the reaction, the gas mixture was to be led over the catalyst very rapidly. A small experimental plant was erected for trial of the process at Asnières, near Paris, and there the yields obtained by the use of various metal catalysts were studied. Zinc oxide yielded the best results, and a mixture containing 90 per cent. of metallic copper with 10 per cent. of zinc oxide, was found to be more effective than one consisting entirely of the latter. External heating was employed, as Monsieur Patart had found that internal heating, inside the reaction chamber, led to the production of larger quantities of methane and water in place of the desired product—methanol. The methanol produced by the process under the best conditions contained only 5 per cent. of water with small amounts of the higher alcohols and no aldehyde or acetone.

Elworthy, in a report published in *Canadian Chemistry and Metallurgy*, has given further information relating to the result obtained at the experimental plant at Asnières, and has stated that the best yields were obtained at temperatures between 400 deg. and 420 deg. Cent. and at pressures between 150 and 250 atmospheres. He has estimated that the cost of the methanol at Asnières lies between 22 and 32 cents per gallon, and has stated that it had been found unnecessary to employ specially purified gases for the process, since the catalyst used by Patart was not so susceptible to gas poisoning as that used by the Badische Company.

As regards the commercial development of the process, Lormand has reported that it is being used at the Kuhlmann Works, at Lille, but that the methanol obtained by it is only used to satisfy the demands of the organic, chemical and dye manufactures in those works, and the synthetic product is not yet being placed on the market in competition with natural wood spirit.

The Audibert Process.

It is noteworthy that, even in France, the patent position with regard to the synthesis of methanol from mixtures of carbon monoxide and hydrogen gas is not by any means settled, for the Compagnie des Mines de Bethune is operating a process practically the same as that of Patart, but based on the researches of Monsieur Audibert, and there is some dispute between these two chemists as to the priority of their respective claims to be the inventor of the process. Monsieur Audibert is in charge of the work carried on by the "Soc. Nationale de Recherches sur le traitment des Combustibles," and while engaged in this work he has investigated the yields obtained from

* No. III. appeared March 18th.

the Patart and Fischer processes and the temperature conditions which give the best results. He states that when a mixture of hydrogen and carbon monoxide in the proportions of two to one is passed over the catalyst at a pressure of 200 atmospheres, no reaction will take place below 225 deg. Cent. Between 225 deg. and 300 deg. Cent. methanol is formed—with small amounts of CO_2 and traces of CH_4—in accordance with the equation given below—

$$CO + 2H_2 = CH_3OH.$$

The upper temperature limit depends upon the nature of the catalyst, and above 300 deg. Cent. water and methane are produced, in addition to the methanol. Under the most favourable conditions, when using uranium oxide as a catalyst, Audibert produced 800 c.c. of methanol per hour, with an apparatus of only 20 c.c. capacity, and using only 8 grammes of the catalyst, supported on asbestos. The methanol produced under these conditions contained only ·5 per cent. of water; its specific gravity was ·792, and its distillation temperature ranged from 66 deg. to 68 deg. Cent.

Furness, in a recent issue of the *Industrial Chemist*, has published some interesting calculations based on the above figures as to the cost of producing 2500 gallons per day of methanol by the Patart process. He estimates that the raw materials would not cost more than 4d. per gallon, and that, judging by the experience gained with the Haber process of synthetic ammonia production, the running and overhead costs would add about another 4d. per gallon to this total.

In view of these figures, there is no doubt that sooner or later synthetic methanol will be placed on the market in competition with the product of the wood distillation works; but before methanol can be generally adopted as a substitute for petrol, considerable alteration will be required in the design of motor engines and carburetters. For some time to come therefore the chief market for synthetic methanol will be in the field of manufacturing chemistry. Before leaving the subject, attention may be recalled to the fact that it was the two famous French chemists, MM. Sabatier and Senderens, who first pointed out the possibility of producing this alcohol from mixtures of hydrogen and carbon monoxide gas. Although they were unable in their own experiments to produce methanol in any quantity, and only obtained methane, they recognised quite clearly the industrial possibilities of the process, and their early work certainly paved the way for the later investigators, who have attained complete success in this particular branch of synthetic manufacture.

THE FISCHER AND TROPSCH PROCESS FOR THE SYNTHETIC PRODUCTION OF MIXTURES OF THE HIGHER ALCOHOLS.

Dr. Fischer is the head of the well-known Kaiser Wilhelm Inst. für Kohlenforschung, in Mulheim-Ruhr, and is also editor of the German bi-monthly technical journal *Brennstoff Chemie*. The following account of the process which he has worked out in conjunction with Dr. Tropsch for the production of mixtures of the higher alcohols, to which they have given the trade names of "synthol" and "gasol," is based partly upon an article published in *Brennstoff Chemie* in 1924, and partly upon an address delivered by Dr. Fischer at Pittsburg in November, 1926, before the International Conference upon Fuel and its Utilisation.

The earlier contribution contains an account of the experimental work carried out by these two investigators up to the end of 1923. As the result of this work, which resulted in the production of "synthol," they give the following as the conditions required for the production of this liquid fuel from mixtures of hydrogen and carbon monoxide gas:—

(1) The catalyst should consist of a hydrogen-carrying metal and of an alkali. Iron has been found to be the best metal for the purpose, and rubidium hydrate or carbonate the best base. The metal should be in the form of chips or shavings, and sufficient alkali should be employed to convert the surface of the chips into "ferrite," but an excess of alkali must be avoided.

(2) The best temperature for the reaction is 410 deg. Cent., when iron is employed; but it must be higher if nickel is substituted for iron. A single passage of the gas over a catalyst gives only a low yield, but by re-circulation of the gas 27 per cent. can be recovered in the form of oils and alcohol. The catalyst will remain in full activity for a week, but gradually becomes reduced to powder.

(3) The richer the gas used is in hydrogen, the higher will be the yield of watery products. Mixtures of CO_2 and hydrogen can be employed for the reaction, but they require longer contact with the catalyst than mixtures of CO and H, while gas mixtures containing CH_4 with CO_2 or CO do not yield any synthol at all. An essential condition of success is that the gas mixture employed shall be as free as possible from sulphur compounds.

When the above conditions are observed the authors state that an oily and watery mixture is obtained, containing alcohols, aldehydes, acids and ketones. One-half of the oil can be volatilised by steam, yielding a mixture of ethyl and propyl alcohols, with ether and some of the higher alcohols. This mixture, to which they have given the trade name of "synthol," has a specific gravity of ·8289, and 90 per cent. of it distils below 200 deg. Cent.

In the address delivered at Pittsburg, Dr. Fischer stated that, since the completion of the earlier work, he and Dr. Tropsch had been investigating the conditions which were required to increase the amount of the oily layer, and to reduce the proportion of the watery compounds obtained in the original experiments. As a result of this work they had discovered that exact temperature control was the key to the suppression of the formation of methane, and that for each type of catalyst employed in the reaction there was a temperature limit which ought not to be exceeded. For most catalysts, this temperature limit is 300 deg. Cent., and they now regarded that particular type of synthesis as a combination of hydrogenation and polymerisation. The amount of polymerisation that occurs can be controlled by varying the basicity of certain added compounds which are mixed with the catalyst, and Dr. Fischer stated that working in this way they could produce as desired, either mixtures of the light paraffin oils or the heavier oils, leading up to paraffin wax. A mixture of ethyl, propyl and butyl alcohols, to which they had given the trade name of "gasol," was most easily produced, but the condition required for the production of benzol had also been determined. As regards the theory of the process, the patentees have advanced the hypothesis that metallic carbides are formed as intermediate products, although so far they have not been able to separate these carbides in pure form. The new method of synthesis can be carried out at normal pressure, but it is essential that the gases used shall be quite free from sulphur and other impurities, and a simple and inexpensive method of carrying out such purification has been devised. Any technical gas, such as water gas, producer gas or blast-furnace gas can now be employed for operating the process, with satisfactory results. Finely divided cobalt or iron are used as catalysts without any activating admixture, and the special feature of the process is the use of temperatures between 200 deg. and 300 deg. Cent., which are too low for the formation of methane. The disadvantages resulting from the use of such low temperatures are compensated for by the longer life of the catalyst and contact mass.

As regards yield, a 50 per cent. production of the paraffin hydrocarbons can be obtained with one passage of the gas mixture over the catalyst, and as regards absolute yield, 100 grammes of liquid or easily liquefiable hydro-carbons can be obtained from each cubic metre of the gas mixture, when it is conducted over the catalyst several times. The cheapest source of gas supply is blast-furnace gas, which in many districts of iron manufacture is now a waste product. The amount of hydrogen in this gas can be raised to the percentage necessary for operation of the process, either by adding hydrogen to it or by converting a portion of its carbon monoxide contents into hydrogen by the use of superheated steam. This method has been described already in article No. III. of this series.

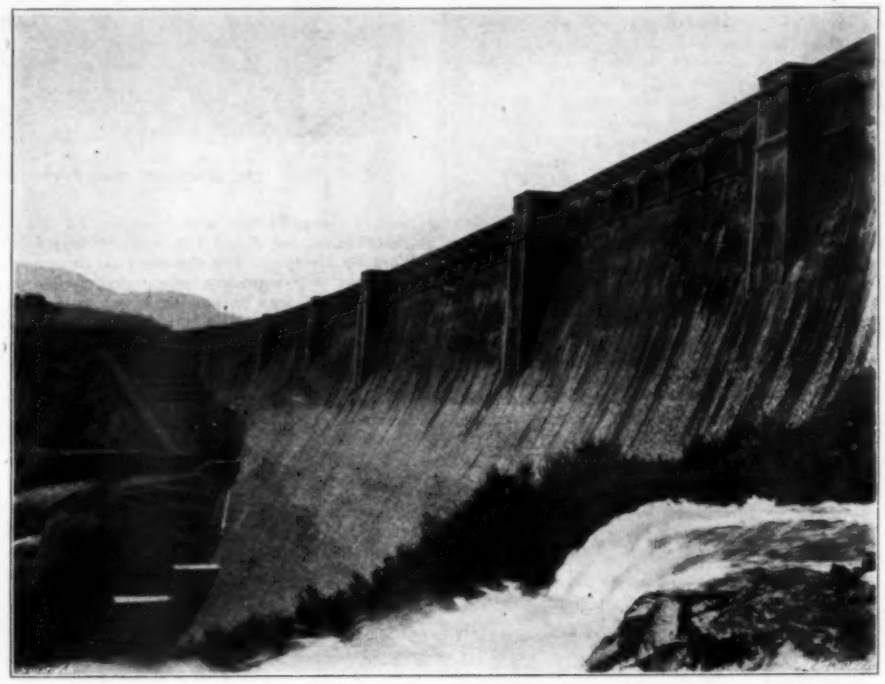
No information is available concerning the industrial development of the Fischer and Tropsch process, and, so far as the writer is aware, the production of "synthol" and "gasol" upon an industrial scale has not yet been started in Germany. These synthetic products, however, will probably become of considerable importance in the near future, and a company has been formed at Mulheim to take charge of the commercial exploitation of the Fischer and Tropsch patents.

(To be continued).

The Wilson - Bhandardara - Dam, Bombay.

IN our issue of December 17th last we gave two small views of, and printed a short reference to, what was first known as the Bhandardara Dam, which has been constructed on the Pravara River in connection with an extensive irrigation undertaking known as the Pravara Right and Left Banks Scheme. This dam was formally put into service on December 10th last by his Excellency Sir Leslie Wilson, the Governor of Bombay, in whose honour it has been re-named the "Wilson" Dam. By the courtesy of the Director of Information of Bombay we are enabled to give the following additional information regarding this important structure and to reproduce the larger views of it, which appear herewith and on page 328. The photographs from which the two latter were reproduced were taken at the time of the opening ceremony.

The Wilson Dam is situated close to the edge of the Western Ghats at an altitude of 2452ft. above mean sea level, at a distance of 75 miles north-east of the city of Bombay, and of 65 miles from the coast. It is by far the highest dam in India and is second in height only to the Exchequer Dam in the Merced Valley, California, which was completed a short while ago and is 45ft. higher. In our original note we gave the height as being 270ft., but that figure is, we now understand, the greatest depth of water that can be impounded, the height of the dam itself being over 282ft. from the bottom of its foundation, while its maximum thickness at the base is 234ft. The materials of which it is constructed are black basalt or trap rock and Kankar lime.



DOWNSTREAM FACE OF WILSON DAM FROM NORTH BANK

Lake Arthur Hill, which is formed and contained by the dam, is about 8 miles in length and has a capacity of over 10,000 million cubic feet of water, the catchment area being 47 square miles. The water can be let out at various levels into the natural bed of the Pravara River below, and passes down the river bed for 53 miles to the Ojhar Weir, a low pick-up weir built across the river at Ojhar. At the ends of the pick-up weir the two canals, by means of which the water is distributed on each side of the valley, take off, namely, the Pravara Left Bank Canal, which is 48 miles long and commands an area of 125,000 acres, and the Pravara Right Bank Canal, 33 miles long, which commands an area of nearly 75,000 acres.

The capital cost of the irrigation system amounts to 151 lakhs of rupees, or over £1,100,000, taking the rupee at 1s. 6d., and the annual revenue is put at 6 lakhs of rupees—say, £45,000—out of which sugar cane alone yields 4 lakhs—say, £30,000.

Situated as the neighbourhood is, in a country of precipitous hills broken up in every direction, particularly near the Western Ghats, with innumerable valleys cut out from the hills by the monsoons of countless centuries, the problems to be faced by the Deccan irrigation engineer are, as can well be imagined, of great magnitude and difficulty. That many of those problems have been successfully over-

come, as is evidenced by the large number of schemes which have been carried out during the past fifty or sixty years, is greatly to the credit of those who have been responsible for the carrying out of the projects. The Wilson Dam, on which the Pravara system of canals depends, is the boldest and most spectacular of all the works hitherto undertaken, and it forms a fitting monument to the work done by the Government of Bombay to protect the country from the ravages of famine.

We may add that the whole work was designed and carried out by the engineers of the Public Works Department of the Bombay Presidency.

Delaware River Suspension Bridge, U.S.A.

No. IV.*

Main Cables.—Each of the two great cables—30in. in diameter—from which the bridge structure is suspended, is composed of 18,666 straight, parallel, galvanised steel wires of 0·195in. diameter, or 0·196in. when galvanised. The wire, made at the mills in lengths of 3300ft., drawn from billets of acid open-hearth steel, has an ultimate tensile strength of 220,000 lb. to 230,000 lb. per square inch. Its modulus of elasticity is 27,000,000 lb. per square inch. Under the specifications it was required to have 215,000 lb. ultimate tensile strength, with a yield point of 144,000 lb. and an elongation of 4 per cent. in a length of 10in. These requirements were exceeded in the wire produced.

The wires as built up into each cable are arranged in sixty-one bundles or strands of 306 wires to each strand. These bundles were finally compressed and bound together in approximately hexagonal form within a circle of 30in. diameter—as shown by the cross sections, Figs. 17 and 18. The two cables, each 3560ft long between anchorages and containing some 25,100 miles of wire, weigh together about 7000 tons, and have a sag or deflection of 200ft. in the main span of 1750ft. They are designed to carry a pull of 18,500 tons, but their actual tensile strength is about 57,500 tons.

Each strand, 3560ft. long over its anchorage attachments, consists of an endless wire looped back over a shoe—shown in Fig. 17—at each end, the several lengths of wire being spliced by threaded sleeves. The ends of each length—about 3300ft.—are threaded and cut at an angle of 45 deg., so that the adjacent ends lap and thus lock each other, as in this position they cannot turn in the sleeve. Although the cross section of the wire is reduced about 18 per cent. in the threads, tests made in the laboratory and during the spinning of the cables in place, showed that the strength of the spliced joint was 95 to 98 per cent. of the strength of the solid wire. This was due largely to the hardening effect of the swaging. After the steel sleeve or ferrule was screwed up until the ends of the wires met and locked, the threads were swaged on the wires by a power machine having hammers striking the wires with about 2400 blows per minute.

Tests were made also of wires reduced to half their normal section by grinding, in order to discover the possible effect of surface rusting, but no appreciable weakening was indicated. At the anchorages, the wires of each strand are spread to loop around a grooved block or shoe, of horseshoe shape, slipped on a pin which is held in the ends of a pair of heavy eye-bars. In tests of the effect of looping the wires over the anchorage shoes, the wires broke always in the straight portions instead of in the loop or bight. Tests of wires made up in strands of parallel wires, as in the cables, showed a strength 94 to 96 per cent. of that of single wires. Finally, tests of wires under lateral pressure, as in the cables lying in the saddles, showed about 99 per cent. of the strength of free wires in plain tension. All these wires were made by the Page Steel and Wire Company for the American Cable Company. They were delivered at the bridge works in coils of about 3300ft., and there spliced and wound on reels containing about 100,000ft. of wire.

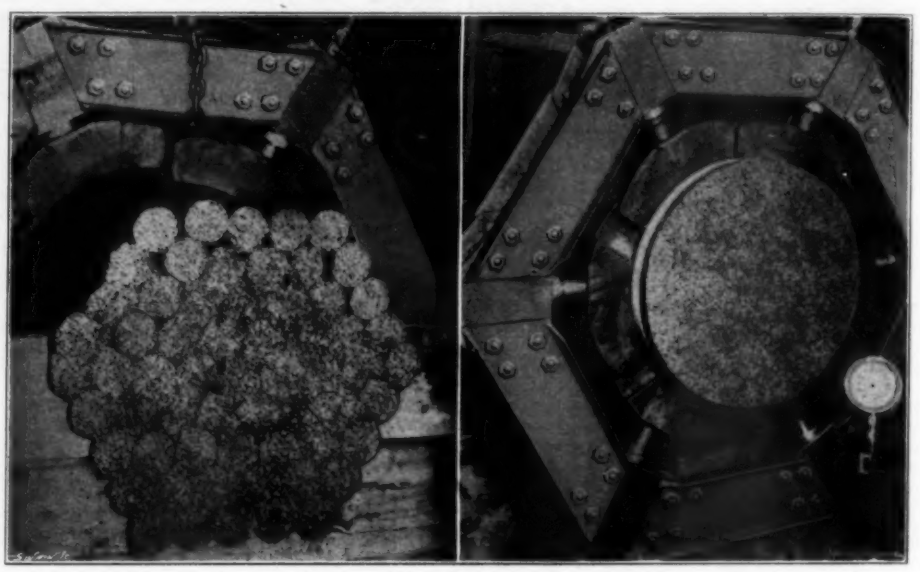


FIG. 18—CABLE COMPACTING MACHINE, BEFORE AND AFTER OPERATION

Working Bridges.—For the erection or spinning of the cables, a temporary suspended footbridge or working bridge was built a little below the position of each main cable. Each footbridge consisted of six 2¼in. wire ropes, held at the anchorages and laid in saddles at the outside of and below the level of the main saddles on the river towers. Across these ropes were laid planks, 10ft. long, forming the footbridge. Transverse platforms connected these two lines of footbridges to facilitate access to different parts of the work, there being three of these platforms in the central span and one on each side span. These platforms, supplemented by diagonal storm cables, served also to prevent swaying of the footbridges. A general view of the working bridges and platforms before the cable work was begun was shown in Fig. 3 *ante*, while they appear also in the accompanying pictures, Figs. 19 to 22.

The first four of these 2¼in. temporary cables, wound on reels, were carried over the river on a barge which was towed across, the ropes being paid out and laid along the bottom of the river, where they were left until the remaining eight were also laid. Then on June 10th, 1924, while river traffic was suspended for a short time, the ropes were hoisted up the towers and placed on the temporary saddles. Sections of the plank flooring were then hoisted and quickly attached to the ropes. After these construction cables had served their purpose they were cut up into lengths to be used as suspenders in the permanent structure. In these ropes the wires are laid spirally in the usual way, instead of being straight as in the main cables.

Spinning the Cables.—In the work of spinning or stringing the cables, as carried on by the Keystone State Construction Company the wire was carried back and forth on travelling sheaves hung from frames attached to two endless ropes driven by electric motors. Each rope had two of these sheaves about 3200ft. apart, so that they stood normally at the opposite anchorages. One of these ropes was hung above the position of each main cable. Reels containing about 100,000ft. of wire were arranged near each anchorage, being mounted so as to revolve around an axle carried on side bearings.

In beginning a strand, at each anchorage the end of a wire wound upon a reel or drum was fastened to an anchor shoe—Fig. 17—and the loop or bight was passed around the grooved sheave hung from the endless travelling rope. This rope was then started and carried its two sheaves across the river in opposite directions. When each sheave reached the anchorage, the wire was removed from it and passed around the anchor shoe, which was laid temporarily in a horizontal position. In this way the two sheaves added four wires to the strand at each trip. When the wires had been adjusted to the proper sag, and clamped to the shoes, the travelling rope was started again, and the sheaves carried four more lines of wire back to the anchorages from which they had started. If kinks or sharp bends formed in the wires, which rarely occurred, the kink was cut out and the ends of the wire were spliced.

When the strand had its complement of 306 wires, making a spliced length of about 1,086,000ft., the spinning was stopped and the strand or bundle of wires was bound with clips of steel 2ft. apart. After this completed strand had been placed in the saddles by means of hydraulic jacks, it was adjusted to the correct sag as determined by a guide wire. This adjustment was made by means of ratchet jacks at the top of the towers and hydraulic jacks at the anchorages, the latter being attached to the strands by grips or clamps which were carefully wrapped to prevent any scratching or injury of the wires.

Finally, each anchorage shoe was turned up on edge and set between the beads of a pair of eye-bars, a pin being then passed through the shoe and the bars. The highest record on this work was the stringing of 578 wires in a twelve-hour day. All the wires were strung during a period of twenty-four weeks.

Shaping and Wrapping the Cables.—The cable as built up of bundles or stands of wires, as already described, was of approximately hexagonal section, 35½in. in diameter, when ready for compacting, and was held in this shape by temporary clamps or frames at intervals. It retains this shape in the saddles—where it is not wrapped—as shown in Fig. 18, but elsewhere it is compressed into practically a circular section.

The great size of the cables made it necessary to design special apparatus for compressing or compacting the sixty-one relatively loose strands into an approximately cylindrical form, 30in. in diameter, with a cross-sectional area of 562 square inches, to receive the cable bands for the suspenders. On the smaller cables of earlier bridges a clamp or yoke, consisting of two semi-circular members hinged together, was used. When set astride of the cable, the free ends were drawn together by a hydraulic jack,

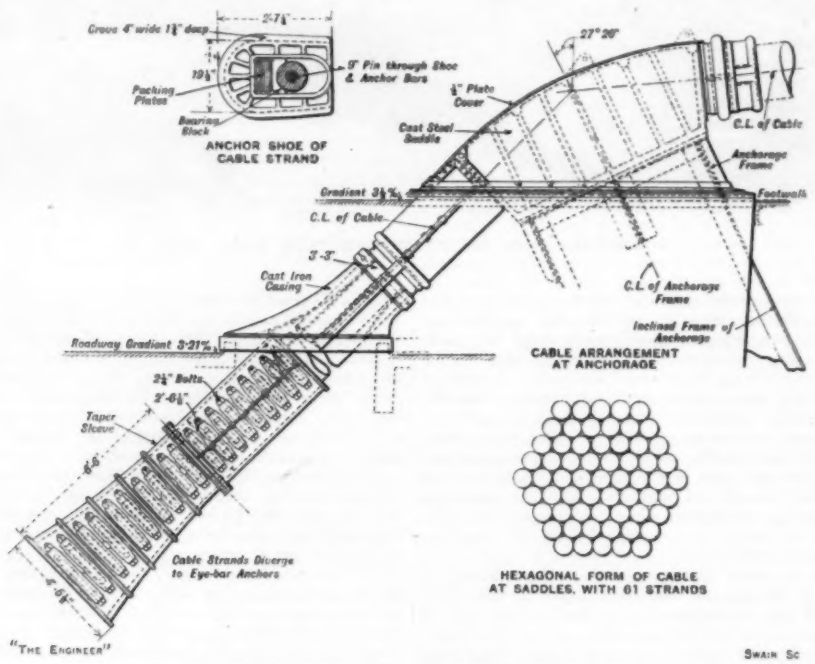


FIG. 17—ARRANGEMENT AT ANCHORAGE OF CABLE

* No. III. appeared March 18th.

FIG. 19—SOME OF THE CABLE STRANDS

FIG. 20—COMPACTING THE CABLE STRANDS

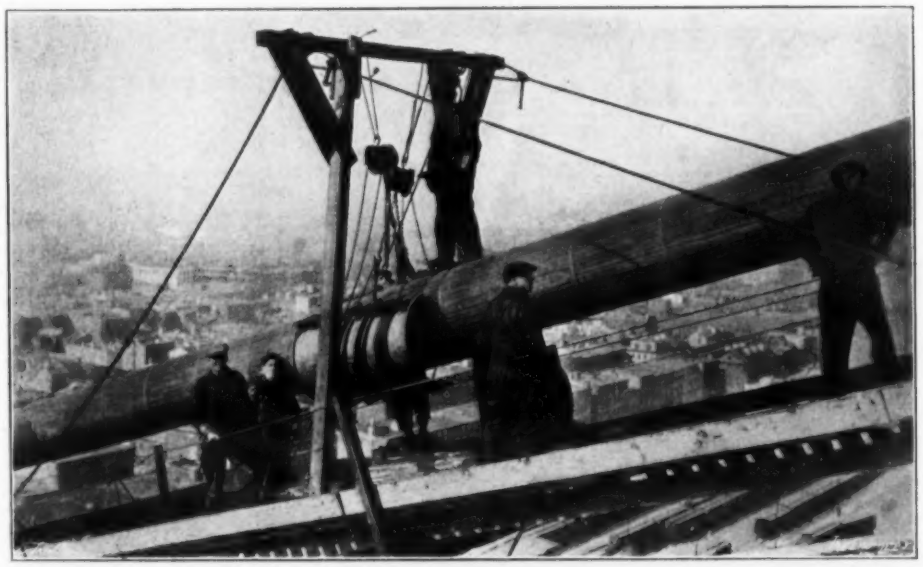


FIG. 21—PLACING THE SUSPENDER BANDS

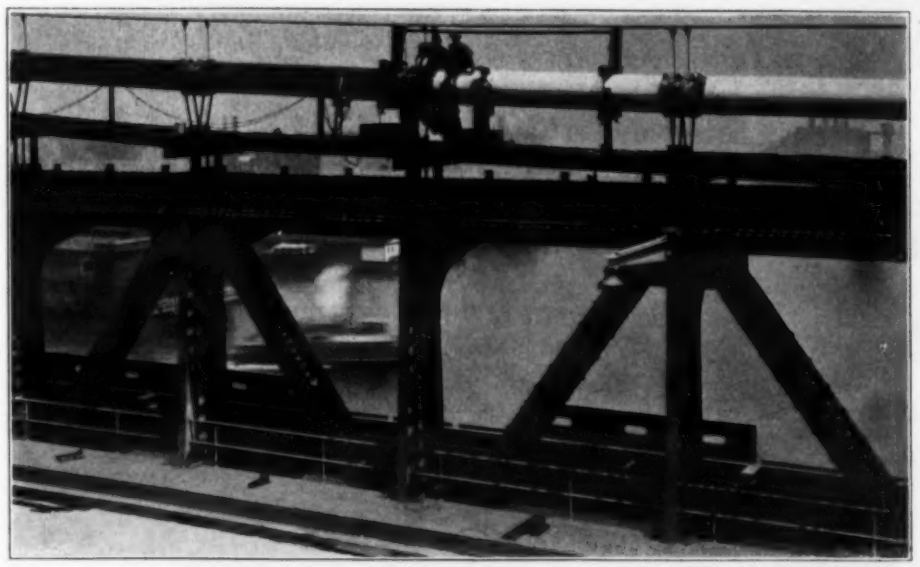


FIG. 22—WRAPPING THE MAIN CABLE

compacting the wires into a solid mass. This device was not of suitable shape or of sufficient power for the cables of the Delaware River Bridge.

To meet these conditions a clamp was designed—Fig. 18—composed of a yoke or frame of hexagonal form, built up of rolled steel channels and having six hydraulic jacks arranged radially, one at each angle of the frame. On the head of the plunger of each jack was fitted a shoe having its face machined to a circular form of 15in. radius. As pressure was applied to the jacks simultaneously, this pressure was distributed around the entire circumference of the cable, thus avoiding any chance of distortion. In this way the mass of wires or strands was steadily compressed and reduced to the required diameter, and was then secured by bands to hold the shape.

The pressure was then released, the jacks were slacked off and the machine was shifted forward along the cable. In Fig. 18 the machine is shown, with the loose strands at the left and the compacted cable at the right. With a pump pressure of 6000 lb. per square inch, the total maximum pressure exerted around the cable was about 30 tons. For the first 5in. of the reduction in size a pressure of about 15 tons was sufficient, but the full pressure was then required to make up the last ¼in. of movement or compression.

In the group of views given on page 519, Fig. 19 shows several of the cable strands not yet laid up into a cable. The upper strand at the left is being lowered into the saddle, while the one at the right is lying in the grooved pulleys in which the wires were strung. The compacting of the cables, which was done during January–March, 1924, is shown in operation in Fig. 20. Here the men are standing on the working bridge in front of the cable strands. Beyond them is the machine, beyond which again is the compacted and banded, but unwrapped, cable.

Cast steel bands to carry the suspender cables are made in two flanged sections which are clamped upon the cable and drawn tight by 1⅛in. bolts of high-tension steel put through the flanges. Fig. 21 shows the two parts of a band being set in place on the cable by means of a pair of chain hoists slung from a movable gallows frame. Between the suspender bands the cable is protected from the weather by a spiral wrapping of galvanised steel wire, 0·148in. in diameter, which was applied under strong tension by a power-operated machine—as shown in Fig. 22. In this view, with the wrapped and finished cable at the right, are shown the cable bands and suspenders and the permanent hand ropes. It gives also an idea of the massive construction of the stiffening trusses. The wrapping was finally given a heavy coating of paint.

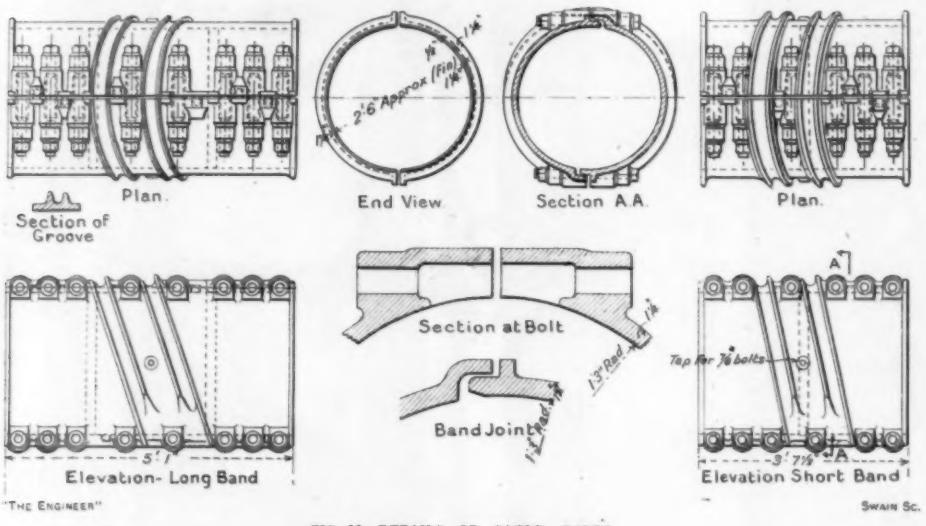


FIG. 23—DETAILS OF CABLE BANDS

It will be noted that the suspender bands are clamped directly upon the bare cable, the ends of the wrapping wire being caulked into a groove in the band. An improvement over earlier practice was in winding the wrapping wire from the low point upward, which method aided in keeping the wire coils in close contact. On the Brooklyn Bridge, the wrapping began at the towers and proceeded downward. It may be noted also that in the Brooklyn Bridge the wrapping was continuous along the entire span of the cables, and the suspender bands were applied over the wrapping. But the placing of these bands on the unwrapped cables of the Delaware River Bridge is considered to give greater security against slipping.

At the towers the wrapping is finished against castings bolted to the hoods which enclose the saddles and cables. At the anchorage saddles the wrapping is finished against the end of a cast steel sleeve which covers the cable.

The cable bands—Fig. 23—are made from electric steel. They vary in length according to the increasing slope of the cable and the additional number of clamping bolts required. Their internal surfaces were machine finished with a fine cut. Heavily ribbed grooves on the outer surface are provided to receive the suspender ropes.

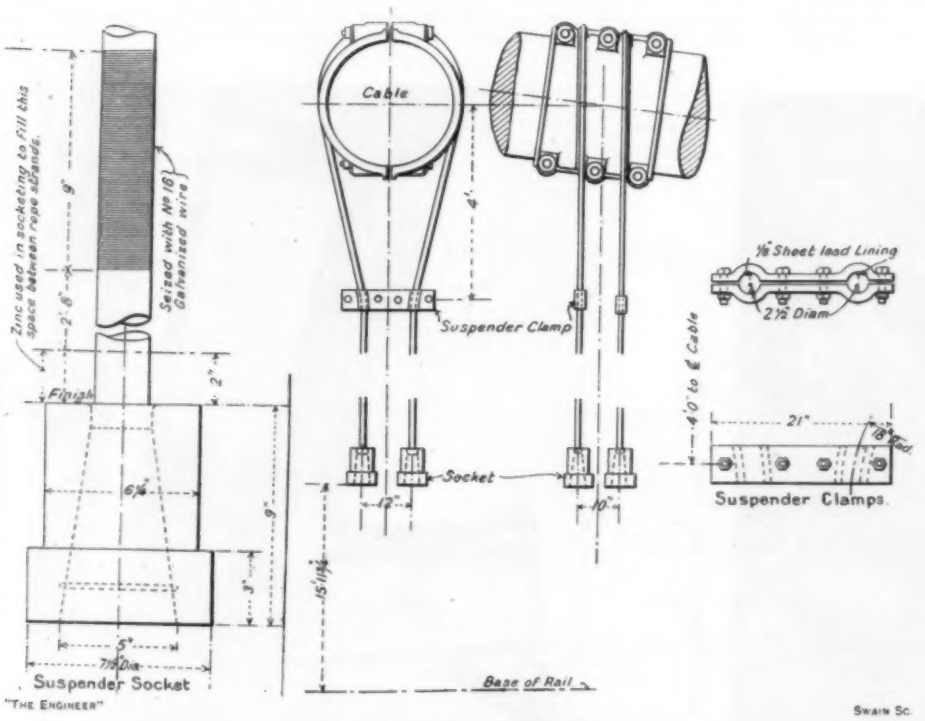


FIG. 24—ARRANGEMENT OF SUSPENDERS

Suspenders.—The riveted steel structure consisting of the stiffening trusses, floor beams and floor framing, is hung from the cables by 596 suspenders, which are spaced 20ft. 6in. between centres in the main span and 20ft. 8in. in the side spans. The suspenders are shown in Fig. 24, and appear also in the view Fig. 22. Each suspender consists of a pair of 2½in. wire ropes or slings looped over the cable, with their bights seated in grooves on the suspender band clamped to the cable, while their hanging ends form the attachments to the steel work. Just below the cable the two ends of the suspender rope are drawn in by a clamp to the required spacing of the vertical parts of the suspender ropes. The clamp is composed of two flat bars, ¾in. by 6in., 21in. long, and stamped to shape, so that when bolted together they form two inclined grooves of 18in. radius to receive the ropes. To prevent chafing of the ropes, these grooves are lined with ⅛in. sheet lead.

These suspenders were of the usual spiral construction consisting of six strands of thirty-seven wires, each wound upon a wire rope centre made of seven strands of seven wires each. The wires are of open-hearth steel, galvanised. Before being placed, the ropes were cut to exact length. The ends were spread to separate the wires, which were then cleaned with acid, washed and again closed together. Each end was passed through the small end of a tapering cast steel socket. The wires were spread apart and the socket was filled with molten zinc.

The suspender ropes pass through sleeves or hollow lugs riveted to the upper ends of the post of the stiffening trusses, a flange on each socket taking a bearing against the underside of the sleeve. Steel packing pieces between the socket and the sleeve provide for adjustment in length of the suspender, and locking plates hold the socket in place. This attachment of the suspenders to the suspended structure was shown in Fig. 12 *ante*. The maximum load at any suspender is 400,000 lb., while tests of these ropes showed a strength of about 380,000 lb., when looped over 32in. sheaves, corresponding to the cable bands. Thus there is a factor of safety of nearly four for each suspender. Above each main cable are strung two permanent 1in. hand ropes, kept in proper position by hold-down ropes which are looped under the cable, as shown in Fig. 22.

(To be continued.)

The Leipzig Fair.

No. III.*

HALL NO. 11.

THIS building, which nominally housed "tools and machine parts," contained many objects of engineering interest. Machine tools, and particularly wood working machines, were fairly plentiful, being exhibited presumably by firms that were not members of the associations which share the huge Machine Tool Building, No. 9. A Maag gear-cutting machine could be seen generating toothed pinions and several horizontal and vertical milling machines of equal reputation. Amongst the novel machines were some centreless grinders exhibited by the Herminghausen-Kaeferle-Werke, of Hanover. These machines are of very simple construction. The work lies in a V-shaped trough and comes under the action of a broad grinding wheel mounted on a horizontal spindle and cutting with its cylindrical face. Opposite the grinding wheel and driven very slowly in the opposite direction is a smooth-faced roller wheel which supports the work against the grinding. The spindle of this roller is inclined to the horizontal, with the result that the work is caused to travel longitudinally along the groove as it is being ground. The rate of travel can be adjusted by altering the inclination of the roller. By tipping the roller in the other sense, which can be done by a hand lever, the direction of traverse can be reversed, thus enabling work to be ground up to a collar or shoulder. Several types of the machine were shown, some with two or more heads acting on the work in succession. The machines are useful for the rapid grinding and polishing of short or long cylindrical parts of steel, brass, wood, ebonite, galalith, &c. They will deal with diameters ranging from 2 mm. to 100 mm. and lengths up to 6 m. When special accuracy is required, such as for machine parts, a somewhat more elaborate machine, though working on the same principle, is employed. It, it is claimed, will finish work to an accuracy of one-hundredth of a millimetre, or four ten-thousandths of an inch.

Another interesting machine was one for shearing thin metal sheets to any curved form desired. The cutting part of the machine appeared to consist essentially of a pair of steel knife blades, like those of ordinary shearing machines, set at a small angle. The upper blade was fixed, but the lower one vibrated or oscillated on a vertical plane with such rapidity that the eye could not follow it. This blade appeared to be mounted on a sort of excentric strap, the excentric being directly on the shaft of an electric motor. When the machine was running the operator

* No. II. appeared March 18th.

could pass a plate of sheet steel about ¼in. thick between the blades and cut it very rapidly indeed in any kind of curve without apparent effort. Still another device of mechanical interest was a form of geared electric motor, shown by the Albert Obermoser Elektromotorenwerk, of Bruchsal, Baden. On the stand of this firm was a number of small totally enclosed motors of about 1 horse-power. The pulleys, which were axially in line with the motor spindles, ran at speeds as low, in one case, as 3 revolutions per minute, and at 300 or 400 revolutions in other cases, although the motors were running on 50-cycle current. Apparently some form of epicyclic gear was interposed between the motor and the pulley, but whatever it was it required extremely little axial space and ran silently. The whole design was very attractive.

Among the woodworking tools in this building was a neat device for making wooden handles, such as those of trowels, paint brushes, &c., or for forming the ends of longer handles. This was a kind of hollow box cutter, with inwardly projecting knives. The box was fixed in the revolving mandrel of a simple machine, and the handle to be formed was just pushed into it. If the handle had to be under-cut or to have grooves round it, or to be of such a form that it could not be made in the simple manner described, the box was furnished with an auxiliary forming tool carried on the one arm of a bell-crank lever. When the handle was pushed home, it came in contact with the other arm of this lever, and thus caused the auxiliary knife to come into action. The withdrawal of the finished handle moved the auxiliary knife out of the way.

It would be as tedious as unnecessary to attempt to enumerate the variety of articles on view, which included automatic lathes, flexible couplings, saw sharpeners, hand tools of all kinds, die castings, &c. &c. There were some very fine specimens of die cast work, such as tiny toothed pinions, wheels of counters for integrating machines, &c. One firm was exhibiting a machine for die casting non-metallic materials, such as cellulose and galalith, which materially extends the usefulness of this process of manufacture. A further novelity was an instrument called the "Duroskop" for hardness testing. This is an instrument of rectangular shape, about 4in. square and 1in. thick. Inside it is a pendulum which can be raised by a little milled head outside the case until it is held by a catch. The instrument is then placed with one of its edges resting vertically against the specimen to be tested, the verticality being observed by a level on the top edge. The pendulum is then released, and, swinging down, its hardened end strikes the specimen through a hole provided for the purpose. On its rebound it moves a light pointer over a scale, much as the pointer of an Izod impact tester shows the stroke of the pendulum in that machine. The reading on the scale at which the pointer comes to rest shows the hardness, which can be correlated with the well-known Brinell numbers by means of a curve.

HALL No. 12.

Immediately on entering Hall No. 12 the visitor was confronted by a large circular stand occupied by Messrs. Fried. Krupp, of Essen, which, although containing nothing very imposing or spectacular, is, nevertheless, of great technical interest as showing the developments of stainless steel. Seamless tubes of this material were shown in various sizes, the largest being 150 mm. inside diameter by 10·5 mm. thick, and about 30ft. long. A number of centrifugal pumps, guaranteed to withstand nitric acid of any strength, constructed of cast stainless steel, were ranged round the stand. Calorimeter bombs, cutlery and various surgical instruments were amongst the other applications of this kind of steel, but perhaps the most unexpected instance of its utility was in connection with the manufacture of false teeth. During the war the shortage of rubber in Germany was acutely felt by dentists, who could not get a satisfactory quality of vulcanite for dental fittings. Gold plates were also out of the question, so Messrs. Krupp undertook the supply of thin plates of stainless steel, and also furnish suitable presses by which the plates could be moulded to form by the dentist. So satisfactory was the material that no less than 10,000 fittings of stainless steel have been supplied for the mouths of Messrs. Krupp's own workmen. They are equipped either with teeth of the same metal or with porcelain teeth of the usual type, according to the wishes of the patient. The stainless steel plates are perfectly tasteless, and can be used in conjunction with gold without any electrolytic effects.

The majority of the exhibits in this building would come under the classification of ironmongery and builders' hardware. Stoves, kitchen ranges, baths, door handles, safes, locks, and so on, were shown in profusion, and there were many different makes of typewriters and calculating machines. Weighing machines, particularly those of the indicating variety for grocers, were also very numerous. A fair number of stands showed carpenters' tools, saws, knives, &c. The largest single class of exhibits was perhaps that of bicycles, components and fittings. Amongst these, a motor caravan made by Rudge-Whitworth and exhibited by their German agents, was perhaps the centre of attraction. It consisted of a motor bicycle with sidecar, the bicycle also pulling the caravan. The latter was mounted on one pair of wheels under its centre, and contained a couch at each side, together with washing and cooking apparatus. The idea was evidently that the driver and passenger should ride on the bicycle and sidecar by day and find sleeping accommodation in the caravan at night. The bicycle had a single-cylinder, four-cycle, four-valve engine, 88 mm. bore and stroke, rated at 4·99 H.P., but developing 15 H.P. on the brake. It was fitted with a four-speed gear-box. This, and a "Matchless" motor bicycle on the same stand, were the only British manufactures we noticed in the whole of the building. Illustrated catalogues, printed in German and giving prices of the machines in Reichmarks delivered at Cologne, either for cash or for monthly payments, showed an appreciation of the needs of the market which other firms seeking business on the Continent might well imitate.

HALL No. 13.

This building was given over to the Shoe and Leather Fair, which last year was held in the much larger building No. 7, for which the exhibits were painfully inadequate. This year the response of the manufacturers has been apparently better, but much space still remained unfilled. Ladies' shoes seemed the principal manufactured product, but there was quite a good collection of boot and shoe-making machinery also on view. As in the other sections of the Fair, the majority of the machines were to be seen in motion.

HALL No. 18.

Halls Nos. 14 to 17 being non-existent at the present time, the next building to be considered is Hall No. 18. It was occupied mainly by an exhibit organised by the Soviet Government, and contained quite a good display of the raw materials of Russia and Siberia, such as furs, timbers, grains, flax, &c. There were also examples of native workmanship, mostly wood carvings, while literature was by no means neglected.

HALL No. 21.

After another gap in the numbering, owing to Halls 19 and 20 being not yet constructed, we come to Hall 21. Officially, this large building was given over to a special exhibition of fuel, power and heat appliances. A prominent feature of this exhibition was the large display of internal combustion engines, high speed, slow speed, horizontal and vertical, in units up to about 200 B.H.P. Nearly all the engines were running, and although the exhaust pipes were taken away underground, the noise and the state of the atmosphere were not particularly pleasant. The air was rendered worse by the presence of a number of oil and gas-heated furnaces shown in operation. Boiler fittings, valves and boiler-house control apparatus occupied a number of stands, but few novelties were to be observed. Only on one stand, that of Messrs. Schumann and Co., of Leipzig-Plagwitz, did we notice any fitting designed to meet the requirements of extra-high pressure steam practice. This firm showed a boiler gauge glass said to be suitable for pressures from 25 to 60 atmospheres. It was one of the plate-glass window type, but instead of a single glass, there were three, two in line and the other at the side and overlapping the first two. As the water level rose, it would first be visible in the bottom glass; before it reached the top of this glass it would appear in the bottom of the side glass, and before that was "full glass" the water level would appear in the bottom of the upper glass. The idea, of course, is to avoid undue length of any individual piece of glass, in order to gain greater strength, and at the same time to retain the advantages of a long range of reading. The glasses were said to be of special quality, but apparently no attempt had been made to protect them from the dissolving power of the water. Messrs. Schumann and Co. also showed an automatic pressure regulating or reducing apparatus. The main valve in this device is of the double-beat balanced type held open, against the action of a strong helical spring, by oil pressure underneath a piston on the valve stem. The oil pressure is maintained by a small motor-driven pump. There is a leak-off orifice from the oil pressure system, which is opened or closed by the motion of a pendulum. The position of this pendulum, and therefore the oil pressure tending to hold the valve open, is controlled by a pair of diaphragms, which, in turn, are subjected to the pressure on the down-stream side of the main regulating valve. Should this pressure increase, the consequent motion of the diaphragms causes the pendulum to open the leak-off orifice, thus releasing the oil pressure under the piston, and so bringing about a closing of the main valve. When the steam pressure on the down-stream side of the main valve becomes too low, the leak-off orifice is closed, and the main valve is thus opened wider by the increase of the oil pressure.

Boiler feed pumps both of the reciprocating and centrifugal types, were to be seen, Messrs. Klein, Schanzlin and Becker, of Frankenthal, Rheinpfalz, showing a very interesting example of the latter. It was quite a large pump, designed to take the condensate of a steam turbine, heat it, and put it straight back into the boilers. The pump is of the six-stage type and after the condensate has passed through the first two stages it is returned to the inlet of the third stage by a curved external pipe. In this pipe connection is a heater of the contact type supplied with steam bled off from between the high and low-pressure sections of the turbine. The arrangement looked practical and simple, and we were informed that a feed-heating pump of this type was giving satisfactory service in one of the largest chemical works in Germany. Among centrifugal pumps for other duties was one circulating a mixture of water and paper pulp out of a tank and into it again. The object of the exhibit was to demonstrate the ability of the pump to deal with fibrous materials without getting clogged, and it certainly did this very well, though it incidentally demonstrated something else also. The discharge of the pump was vertical, the liquid passing up first through a gate valve, then through an easy 90 deg. bend and along a horizontal length of pipe to a downward bend which delivered it into the tank. A part of the wall of the horizontal pipe had been cut away and replaced by a glass window curved to the same radius. Through this window the pulp could be seen passing along the pipe with an irregular and violent turbulence which was fascinating to watch. It made one wonder how many Venturi meters, pitot tubes, orifice meters and other measuring devices were expected to give accurate readings under equivalent conditions, and it also raised the question as to how far one must really get away from a bend in order to have even reasonably steady flow in a straight pipe.

The greater attention which is now being given to boiler-house practice was reflected in the numbers of meters and instruments to facilitate economical operation. Apparatus for measuring CO_2 is now very different from what it was in the days when the instruments looked like a lot of glass tubes and bottles in a wooden box and were chronically out of order. The designers are beginning to understand boiler-house conditions and to provide substantial instruments which can be read at a glance at a considerable distance in spite of the gloom which usually pervades boiler-houses. One gathered the impression that recording CO_2 meters were giving place to instruments which indicated only, and that engineers were also desirous of having indicating meters to show the percentage of combustible gas ($CO + H_2$) in the flue gases. The latter percentage is determined, of course, by passing the gases which leave the CO_2 meter through an electric furnace which oxidises any remaining combustible, the difference in the quantity of CO_2 resulting from this process being a measure of the unburned combustible gases present. Among the water meters we noticed one built exactly on the lines of the old Kennedy positive integrating type, which did such good service in feed water measurement until power-house demands became greater than the principle was suited for. The meter exhibited, however, was fitted with a graphic recording device, the strokes of the piston being shown as a series of zig-zags on the chart. These were crowded together and acute angled when the flow was fast, and were more extended and obtuse as the quantity of water passing was lessened, a horizontal straight line indicating no flow at all.

THE YARD EXHIBITS.

We have now dealt cursorily with the contents of all the fifteen halls occupied by the Technical Fair. These, however, did not house by any means the whole of the exhibits. A large amount of open-air space was also occupied along the sides of the buildings and flanking the roads where the buildings of the future will stand. Some of the open-air exhibits, such as those of Messrs. Bleichert, the Allgemeine Transportanlagen Gesellschaft, and other companies took the form of imposing runway structures, telpher plants, hoisting gears, &c., nearly always shown in continuous operation. There were, in addition, road rollers, concrete mixers, tractors, roadmaking machines, oil engines, and in fact nearly every kind of machine constructed for or uninjured by out-of-door service. Agricultural machinery, however, was absent. One exhibit which attracted much attention by reason of its spectacular effect and noise when working was a display of cold disc saws shown by the Marswerke A.G., of Nürnberg. The principle of cutting rails, girders, &c., by a fast-running disc of soft steel with a smooth edge, which melts its way through the work by friction, is, of course, very old, such machines having been in use in rail mills for years. For some reason, however, they have never become very popular in spite of their simplicity. The smallest of those shown by the Marswerke Company was a little machine for cutting bars. These were placed in a V guide and the operator cramped them in position by a lever held in one hand, while with the other hand he rocked over the head of the machine carrying the motor-driven cutting disc. This machine would cut through a bar 20 mm. square in thirty seconds. One of the larger machines had the motor and disc mounted on a vertical slide, the disc being fed downwards through the work by hand gear. This would cut a bar 65 mm. diameter through in fifty seconds. Fitted with gear for rotating the work, a bar 120 mm. diameter could be cut off in eighty seconds. Another machine had the disc and motor on a horizontal slide, the work being held in a chuck mounted on trunnions, enabling it to be swung into various positions to suit different kinds of jobs.

Road rollers were in considerable variety, some large superheated steam rollers being exhibited in

sizes up to 31 tons. Motor rollers ranged up to 16 tons, the designs being very diversified, but in general the engine was well protected from the weather. Heavy oil engines running at moderate speeds seemed the most favoured type. Other road machinery included scarifiers, tarring machines, stone breakers, and so on. Among the concrete mixers a novel type was shown by the Wolf Netter and Jacobi-Werke, of Leipzig. This machine takes the form of a ring mounted on rollers and arranged for rotation in either direction at will. The interior of the ring contains a number of tangential pockets and also several baffles. The ring is set so that a contractor's dump wagon can be run into it, the rails passing through the ring. With the ring rotating in one direction the wagon is dumped, the mixture of aggregate and cement falling into the inner circumference of the ring. The direction of rotation is such that the material does not enter the tangential pockets, but remains at the bottom of the ring, where it is thoroughly mixed by the passage of the baffles through it. When mixing is complete the direction of rotation is reversed. The pockets then scoop up the material, carry it up to the top of the ring and then dump it back into the wagon ready to be wheeled away. The machine struck me as most ingenious in principle and appeared to do its work perfectly.

The Institute of Metals.

No. II.*

When the meeting was resumed on Thursday March 10th, the following three papers were read and discussed together:—"The Penetration of Brass by Tin and Solder," by H. J. Miller; "The Penetration of Mild Steel by Brazing Solder and other Metals," by R. Genders; and "The Attack of Molten Metals on Certain Non-ferrous Metals and Alloys," by Harold J. Hartley. In the first of these papers Mr. Miller discusses the cracking of stressed brass articles by a process of intercrystalline penetration when in contact with molten solder of the tin-lead variety, which is associated with the phenomenon of "season cracking" and the penetration of mercury into brass. Tensile tests upon brass test pieces which are surrounded by various molten metals and solders indicate that the stress required for penetration to take place is much higher than that required for the penetration of mercury. Experiments with stressed brass tubes also indicate that high stresses are required for penetration to take place. Some subsidiary experiments with copper-tin alloys indicate that the eutectic composition of the series occurs with about 0·7 per cent. of copper, as against 1 per cent. by Heycock and Neville, 2 per cent. by Guertler, Shepherd and Blough, and 5 per cent. by Giolitti and Tavanti.

The second paper by Mr. Genders, deals with the cracking of mild steel under slight stress when heated and wetted with brazing solder, which is due to rapid intercrystalline penetration of the steel by the brass. Copper behaves similarly to brass, but zinc, tin, and lead-tin solder have no perceptible action. The behaviour of mild steel in comparison with that of other metals when stressed and exposed to corrosive media is considered. It is suggested that the phenomenon of intercrystalline penetration, is in many cases, of a complex character, involving a third factor; and in the last-named paper Mr. Hartley deals with the study of the attack of molten tin and tin containing solders upon brass and copper, taking the time factor into consideration. Penetration of the molten into the solid material occurs when the latter is stressed in tension. Fully annealed materials are attacked at very low stresses with ultimate breakdown.

Sir Gerard Muntz, dealing with the effect of solder on brass, suggested that Mr. Miller would have attained very nearly the same results as those given in the paper if he had applied the same heat and the same stress to the brass in the entire absence of either tin or lead. With regard to the penetration of tin into brass, he considered that Mr. Miller had put the effect before the cause. The solder had got into the brass not because it had cracked the brass, but because the brass was cracked before. Some time ago he had set out to prove to a customer that certain sheet brass cracked owing to the action of solder on it, and it was discovered that the whole secret was the black breaking point of brass. If a strip of brass were plunged into molten solder, and were taken out again in two or three seconds, it would break in two quite easily, but if one waited for another half-minute, it would be found that the brass was as strong as ever it had been. The point was that between about 170 deg. and 350 deg., the black breaking range of brass, the brass was absolutely rotten.

Mr. Harold J. Hartley, discussing Mr. Miller's paper, asked for further details with regard to his solubility determinations, because he himself, in determining the solubility of brass at approximately 300 deg. Cent., discovered on analysis that the tin was by no means homogenous. One section contained about 2·3 per cent. copper, another 2·6, and another just under 2, and the zinc content again varied very considerably. That seemed to be due to inefficient mixing of the metal, and showed that there was some segregation taking place during the experiment. Mr. Miller had suggested that the product formed by the attack of brass by tin was a copper-tin compound, CuSn. His (Mr. Hartley's) experiments, however, suggested that that material, taken from the bottom of the furnace, was an alloy of the two compounds Cu_3Zn_8 and Cu_4Sn.

Mr. U. R. Evans suggested that consideration might be given to the possibility that inter-crystalline penetration might be due to the presence of channels in the metal. There were three main types of inter-crystalline penetration known, *i.e.*, (1) penetration by gases, (2) corrosion phenomena at lower temperatures, of which the season cracking of brass was an example, and (3) attack by mercury and molten solder, &c., at high temperatures. Tammann and Bredmeyer had shown definitely that metals, not only in the cast, but also in the rolled state, were threaded by channels, and that it was possible to drive a dye solution right into the interior of sheet metal by the use of very high pressures. If those pores really existed, the problem of penetration by gases almost ceased to require further explanation, and in the case of the corrosion type of attack also an explanation suggested itself—if the pores became filled with liquid, there would be a special attack in the pores. It would be useful therefore to consider how far the presence of those channels explained the third type of inter-granular penetration.

Mr. S. V. Williams referred to the results obtained about two years ago when brazing a nickel-iron ring—the nickel and iron contents being approximately 50/50—on to a copper cylinder. There was evidence that the brass penetrated into the ring, because when the job was finished it allowed air to leak through into the inside portion. A large number of experiments on lines similar to those followed by Mr. Genders were carried out, and the results were more or less in agreement with the conclusions he had arrived at.

Mr. R. Genders, discussing Mr. Hartley's paper, said that he had carried out experiments which showed that there was no mechanical weakness of the crystal boundary itself. The conclusions come to by Mr. Hartley might be misleading. For instance, he had said that even mercury or any other reagent could never produce an intercrystalline weakness which did not already exist, but he could not possibly have meant that. What he meant was that if there were a weakness, the presence of mercury would intensify it, and if by "weakness" he meant weakness to resist attack—and not mechanical weakness—he (Mr. Genders) would agree.

Prof. F. C. Thompson said that he had been interested in the question for fully five years, and, so far as the explanation of the trouble was concerned, he still felt as far from it as ever he did. He agreed with Mr. Genders that there was something of a very complex nature at the back of it which had not been appreciated up to the present time. A point of practical utility brought out by Mr. Hartley was that, relatively speaking, 80/20 brass was very resistant to attack by molten tin at 240 deg. Cent. The minimum stress required to produce failure after a fairly long time was of the order of 9 tons per square inch, whereas copper and the other brasses failed at somewhere in the region of from 2 to 4 tons per square inch. Commenting on the remarks of Sir Gerard Muntz, he said there was evidence in the paper that additional weakness was present when brass was attacked by some molten metal, but was not present in the absence of that molten metal. He felt that, so far as evidence was available up to the present, there was no alternative to the assumption that the molten metal was the main cause of the trouble. He could go some way with Sir Gerard Muntz, however. The only thing he was satisfied of was that the cracking took place in advance of the penetration of the metal, and that the metal penetrated into the existing cracks.

Mr. D. Lewis instanced a case in which gas must have had a predominating influence in producing brittleness. Brittleness occurred in a part of a platinum wire of a thermo-couple, but at other places the platinum wire was perfectly ductile. Furthermore, the brittleness did not extend all the way through the platinum wire, but there was a ductile cord in the centre. The wire came from a piece of steel in a vacuum. There was a certain amount of reducing gas there, probably carbon monoxide, and it was possible that water vapour was eliminated entirely. There might have been some hydrogen.

Colonel N. T. Belaiew said that gun erosion provided an interesting case of the penetration of mild steel by copper. After a gun had fired a number of rounds, erosion set in, and a certain amount of copper was always to be found in the surface of the gun. The conditions were the sudden attainment of a very high temperature and rather sudden contraction of the surface of the gun, and owing to that sudden heating and contraction, cracks appeared on the surface, so that in that case the cracking of the surface preceded the penetration of the copper.

Dr. W. H. J. Vernon emphasised the need for considering the possibility of structural weakness as distinct from weakness in respect of resistance to attack by the attacking agent. In fire cracking there was a similar phenomenon, and it was extremely suggestive that in the case of fire cracking, as in the case of soldering, some articles would crack and others would not. There was some agency at work, quite apart from the attacking agent itself, and that might be linked up with the question of capillaries.

Professor T. Turner (Past-president) replied on behalf of Mr. Miller, and asked Sir Gerard Muntz whether the sheet brass to which he had referred was cold-rolled or annealed. Having been informed that it was annealed at about 700 deg. Cent. for six hours, he said that he always paid great respect to practical tests, but the remarks of Sir Gerard Muntz had not altered his opinion as to the general character of the trouble and the method of overcoming it. It had been assumed usually that the temperature at which brass became brittle was above 400 deg. It might be that it began to become brittle at a temperature as low as 170, as Sir Gerard Muntz had suggested, but if that were so, it was certainly a temperature much lower than he had ever contemplated. With regard to Mr. Hartley's reference to the solution of copper in tin, and his statement that the tin solution was far from being homogenous, he said that that fact was observed by Mr. Miller. The copper-rich alloy sank to the bottom of the bath, and that lower part might become quite concentrated by a material which, on cooling, was quite crystalline and could be detached. Obviously, the material which Mr. Miller had analysed was from the upper portion, where it had been allowed to remain at rest for a long time, and the excess copper constituents had separated out. Some further explanation was required on the question of the crystal boundary, and whether or not the crack preceded penetration. There might be some combination of views which would help, *i.e.*, that at the boundaries we should expect to get a larger number of cavities, whether filled with gas or otherwise. He was not very much in favour of regarding the presence of gas as the explanation. There were cases in which gas was known to have an effect, but in many other instances the suggestion that gas was the cause of the trouble seemed to him to be the last resort of an empty mind; when we could not find any other explanation, we suggested that it must be gas. He agreed with Mr. Evans that there were pores in metal. If there were pores and blow-holes concentrated chiefly around the grains and not in the middle of the grains, that would help us to see how the mercury or other metals might penetrate more easily in that direction, and so account for inter-crystalline fracture.

Mr. Genders, replying, considered it very probable that mercury vapour was the cause of the cracks extending beyond the limit of attack, and that some other gas might be the cause when tin and solder were used. He did not refuse to accept the statement that there were capillaries in the metal; indeed, he would go further than Mr. Evans, and would say it was possible for the capillaries to pass through the crystals themselves.

Mr. Hartley, replying to the point raised by Professor Thompson, that the 80/20 brass was better able to resist attack than were the other brasses and the copper, said that the 80/20 brass was definitely of very fine grain structure, and he considered that the larger the size of the grains, the more readily penetration took place. He was not at all sure about whether or not the cracking preceded penetration.

The President referred to an experience he had had some years ago with regard to a large quantity of material for hydraulic work, which had to be tested at 10 tons per square inch. At that pressure a considerable number of the castings allowed oil, which was the testing material, to pass right through the structure of the metal. It penetrated between the crystals. He awaited with interest information as to whether it passed through the crystals.

A paper on "The Manufacture and Properties of Hair Springs," by Moore and Beckinsale, was then taken.

HAIR SPRINGS.

The function and essential properties of hair springs and control springs are discussed. The respective merits and disadvantages of steels, ferrous alloys—*e.g.*, Elinvar—and non-ferrous metals and alloys as hair spring materials are indicated. To raise the elastic limit to the required degree, hardening by heat treatment or by cold working is necessary, but all hardening operations are liable to produce a state of imperfect elasticity detrimental to the spring. The use of low-temperature heat treatments to restore elasticity after cold working—drawing, rolling and the coiling of the spring—is described. Steel hair springs are subject to corrosion, but Elinvar is highly resistant. Some details of the manufacture of phosphor-bronze and other hair springs are given, and the selection of material for hair springs required to have a low electrical resistance is discussed.

Dr. G. Sachs (of Germany) was the only speaker to discuss the paper, and he referred to experiments which showed that only in a perfectly tempered material was perfect elasticity obtained—so far as the experiments could show any definite result.

Two papers were then read and discussed together. In one Mr. F. Hargreaves dealt with "The Application of Strain Methods to the Investigation of the Structure of Eutectic Alloys." He observed that investigation of the lead-tin, tin-zinc and copper-silver eutectics showed that straining by suitable methods resulted in markings due to slip, similar to those which occurred in the case of pure metals. The orientation of the lead-tin eutectic was apparently determined by that of the tin.

In the other the same author discussed "The Crystallisation of the Lead-tin Eutectic." He said that straining and etching methods applied to a 30 lb. ingot of lead-tin eutectic showed the exterior to possess the largest crystal size with absence of

* No. I. appeared March 18th.

distinct colonies. The middle consisted of much smaller crystal units in the form of distinct colonies of coarser eutectic structure.

A paper on "The Influence of Calcium on Aluminium containing Silicon," by J. D. Grogan, followed. Calcium, said the author, combines with the silicon present in commercial aluminium, forming a compound, probably $CaSi_2$. This compound is almost insoluble in solid aluminium at all temperatures, and exerts no age-hardening influence. By removing silicon from solid solution in aluminium, calcium improves the electrical conductivity of the latter.

Discussing this paper, Mr. H. Sutton regarded the possibilities of increasing the conductivity of aluminium metal by Mr. Grogan's method as being immense. Messrs. J. D. Edwards and C. S. Taylor, in America, had found by adding metallic calcium to a very pure form of aluminium made by the Hoops process, that the resistivity of the aluminium was progressively increased. Another interesting point found by the American investigators was that, contrary to the general experience—which was that cold rolling increased slightly the resistivity of an alloy—cold rolling decreased the resistivity of aluminium-calcium alloys made from pure aluminium. They had ascribed that effect to the destruction of the eutectic surrounding the aluminium grains, thereby allowing the high-conductivity grains to come into metallic contact. Another American, working in Germany on the same system of alloys, had apparently endorsed the observations of Mr. Grogan entirely.

Dr. Max Hass (Germany) said that the principle of reducing the influence of silicon on the electrical conductivity of aluminium by the addition of calcium was proving of practical value in Germany.

Mr. Grogan, replying, said that he had seen the paper by Messrs. Edwards and Taylor, and agreed that the addition of calcium to aluminium lowered the conductivity if no other element were present. He believed it was almost a general principle that the addition of an alloying element to a pure metal decreased conductivity.

A note on "The Magnesium-rich Magnesium-copper Alloys" was then presented by Mr. Max Hansen. The paper contains the results of investigation of the solubility of copper in solid magnesium and the mechanical properties of some magnesium-rich magnesium-copper alloys. Some indication of the phase boundary of the solid solution of magnesium with copper has been obtained. The micro-structure of quenched and slowly cooled alloys is illustrated by means of photographs. The quenched alloys show no perceptible hardening by ageing. Some mechanical properties of extruded material, both with and without heat treatment, are given.

Dr. J. W. Jenkin (Teddington) stated that in the course of a research on the physical properties of magnesium alloys, now in progress at the National Physical Laboratory, materials similar to those examined by Dr. Hansen had been cast, rolled, and tested mechanically, giving results with which the author's figures compared very favourably indeed. All who had attempted to roll magnesium alloys containing 10 to 15 per cent. copper would be glad to hear from Germany that such material can at least be extruded. The conclusions of Dr. Hansen as to the solubility of copper in magnesium were, however, based on somewhat meagre data and unconvincing photomicrographs. Some slides were exhibited of commercial magnesium showing a eutectic which was apparently that of $Mg - CuMg_2$, although the copper content was in some cases one-tenth of that of the alloys examined by Dr. Hansen. The difficulties of preparing magnesium-rich alloys for microscopic examination were admittedly great, but a much more exhaustive investigation on "constitutional" lines would be necessary before satisfactory conclusions could be drawn as to the solid solubility of copper in magnesium.

Mr. W. R. D. Jones pointed to the importance of magnesium alloys in aeronautical and automobile engineering. Data on the mechanical and physical properties of those alloys, and the results of their systematic investigation, were comparatively scanty, and the Institute was indebted to a German firm for having allowed the results to be published.

It was indicated that Dr. Hansen would reply in writing.

A paper entitled "The Mechanism of Inverse Segregation in Alloys" was then read by R. Genders.

INVERSE SEGREGATION.

The hypotheses put forward to account for the occurrence of inverse segregation in alloys are critically discussed. None is fully in accordance with experimental fact, and it is evident that some factor is involved in the phenomenon, the influence of which has not yet been taken into consideration. Preliminary experiments are described showing that, in extreme cases of inverse segregation, exudation at the surface of the casting occurs simultaneously with the escape of evolved gases. The variation of composition in chill-cast slabs of bronze containing 5 per cent. tin made by various methods of casting were determined. The previous work of the author on the flow taking place in the moulds during the formation of the ingot is considered in relation to these results. A general theory of inverse segregation is advanced, in which the gas constituent in alloys is considered as part of the system. The evolution of gas from solution in the metal is regarded as of primary importance in determining variations in composition in the solid casting. Representative experimental data are explained by means of the theory, and methods of avoiding inverse segregation are discussed.

Professor T. Turner (Past-president) referred to some globules given to him some years ago, rich in sulphide of iron, which had exuded from iron castings. On the cooling and solidifying of the iron, these globules, which were about the size of marbles, had exuded. Since that time many experiments had been performed. The subject of inverse segregation should be divided into two distinct branches, the first typified by the cast iron to which he had referred, or the bronze in which Mr. Genders was interested, and the second by the class of alloy consisting of, say, 15 per cent. copper in zinc. In the first case they were dealing with a constituent which was relatively or practically insoluble in the mass, and which was squeezed out as an insoluble separate body, as in the case of the sulphide of iron or the rich tin constituent. In the other case there was no marked difference in structure when passing from the centre to the outside of the ingot. As the mass of bronze containing an insoluble constituent cooled down, that insoluble constituent would naturally tend to collect somewhere towards the upper centre of the ingot. Pressure was exerted from the outside of the ingot, but there was another form of pressure to which attention had not been given, namely, internal pressure. Wherever there was inverse segregation, there was a range of temperature between the liquidus and solidus of the alloy. In cases in which there was a range of temperature, there was a more or less marked expansion during slow cooling—in some cases very marked. In the case of cast iron at about 1000 deg. the interior gave up its graphite and it expanded 3, 4 or 5 per cent. Therefore, it induced considerable pressure, and squeezed through the pores the insoluble particles of sulphide of iron. He suggested, therefore, that the internal expansion was a very important factor, if not a determining factor, in the case of these insoluble materials. The bronzes expanded similarly, but not to the same extent. In the case of the alloy Cu 15 per cent. and Zn 85 per cent., there was somewhat similar action, except that there was no separate insoluble material; it was presumably a solid solution. The outside cooled first, and the inside cooled more slowly. If allowed to cool very slowly, it would expand during cooling to the extent of more than 5 per cent. The more drastic the cooling the greater the inverse segregation. One effect, if not the most important effect, would be that the outside would solidify without expansion, and the inside would expand, and in so doing it forced out a certain amount of residual liquid material, all of which was of uniform composition, and therefore distributed uniformly throughout the mass. He suggested, therefore, that the explanation of inverse segregation included three things. In the first place, there was the range of temperature between the liquidus and solidus, and apart from that range of temperature there would be no inverse segregation. The second was the initial rapid rate of cooling—if the metal cooled slowly there would be no inverse segregation. Thirdly, the presence of internal pressure, whether produced by dissolved gases or by internal changes in the material itself, as the result of which expansion occurred, one illustration being the throwing down of graphite in the case of cast iron.

Dr. S. W. Smith found it difficult to accept the view put forward by Mr. Genders that the gases evolved during solidification were the cause of inverse segregation, and said it would be interesting to know if Mr. Genders had inhibited inverse segregation by the elimination of gases or in any other way.

Professor F. C. Thompson discussed the arguments put forward in the paper with a view to showing that they were illogical. He could not see any adequate reason for believing that the problem was in the slightest degree associated with gases, and could not help feeling that it was a question of under-cooling.

Mr. S. L. Archbutt said that Dr. Rosenhain—who had been suddenly afflicted with a severe cold, and on whose behalf he was speaking—could not agree that gases were an important factor in producing inverse segregation. He had suggested that if one could produce a hollow casting by pouring an alloy into a metal mould, and as soon as a sufficient thickness of wall had been formed, pouring out the liquid so that there was no enclosed volume of liquid, and if segregation was then found, it would be evidence against the suggestion put forward. Therefore, he had taken a 12 per cent. copper alloy in aluminium, which did show quite marked inverse segregation, and had produced a casting in the manner suggested. The thickness of the wall was about ¼in.; the outer skin had been machined off and an analysis made. The average composition of the melt was 11·57 per cent. copper, but a turning from the outside of the hollow casting showed that the percentage of copper was 12·27. Another determination, taken slightly further in, showed that the content of copper on the outside shell was very much higher than the average copper content of the melt. These results constituted serious evidence against the suggestion that gas evolved in an enclosed volume of liquid could assist in the production of inverse segregation. He had also found that a high casting temperature reduced inverse segregation, and that a slow rate of cooling reduced it.

Mr. Genders, replying to the discussion, was prepared to accept Professor Turner's point that internal pressure contributed to inverse segregation, but he was not aware that in the non-ferrous alloys referred to there was any increase in volume on solidification. All the evidence which he could see could be explained by the evolution of dissolved gases. He asked whether Professor Turner had any data which proved definitely that the expansions shown by the extensometer were due to expansion of the metal and not to expansion due to dissolved gases.

Professor Turner said that he took the proof of the density chiefly. The bar became longer and lighter; it became longer as the density decreased. There might be voids or gas holes.

Mr. Genders said that it was not definitely settled that the expansions were real expansions of the solid metal and not gas. He would work in the future with a view to establishing whether or not any increase in volume on solidification did actually occur. In the absence of expansion, he could not see any other possible factor to produce pressure than evolved gas. He saw no grounds for suggesting that alloys might be classified into very distinct groups—one in which there were the copper-lead alloys, which showed exudations on the surface on casting, and another group in which this exudation was not seen but was detected only by analysis. It was difficult, he said, to draw the line between the two, and he saw no reason to adopt a different explanation for one case than for the other. Referring to the experiment mentioned by Mr. Archbutt, in which an aluminium ingot which had been bled before it was fully solid showed inverse segregation, he said that the presentation of that sample implied that the composition gradient had been established before solidification began. He could not accept that idea for a moment. One must adopt the standpoint that the composition gradient was not established at the very beginning, and that did suggest that, in the sample shown, by some means, by some pressure, inverse segregation had occurred at an earlier stage than one would normally expect it.

The President suggested that in his further investigations Mr. Genders might try inverse segregation with a compound of 30 per cent. lead and 70 per cent. copper, because in his experience it was in that compound that it was mostly shown. We could not watch the formation of the crystals in those metals, but there were other solutions from which crystals were obtained where the formation of the crystals could be watched, and perhaps in that way we might get some idea of what was happening in the closed mould in which the metal crystals were formed.

The remaining papers in the programme were taken as read, and the meetings were concluded.

The Grimsby and Skegness Wireless Beam Stations.

THE short-wave wireless beam transmitting station, designed and erected near Grimsby by Marconi's Wireless Telegraph Company, for the British Post Office, constitutes another step in the construction of the chain of short-wave beam stations, which will link up Great Britain with the Dominions. It is designed to provide two beams, one for communication with India and the other with Australia, and, together with the corresponding beam-receiving station near Skegness, also designed and erected by Marconi's Wireless Telegraph Company, comprises the English end of the beam wireless services for those two Dominions, where corresponding stations have been erected under the supervision of Marconi's Wireless Telegraph Company, Ltd., for the National Wireless Companies.

The transmitter room of the Grimsby station—see Fig. 1—is connected to the machinery room by a short corridor on either side of which the battery room, stores and engineers' offices are situated. The power transformer chamber occupies an elevated portion of the building, and provides a chimney effect, thus assisting ventilation, louvres being provided in the walls for that purpose. Power from the Grimsby Corporation's electricity department is delivered to the station in the form of three-phase, 50-cycle current at a pressure of 6300 volts, and it is transformed down to three-phase current at a pressure of 400 volts between the phases and 230 volts, single-phase current, and current at that pressure is used for lighting and heating the building. From the transformers, the 400-volt three-phase current is carried by underground cables to the 440-volt three-phase switchboard in the machinery room, where it is distributed to the three-phase motors driving the various alternators and generators. There are three main power single-phase 50-k.V.A. Crompton alternators, generating current at a pressure of 1000 volts and 300 cycles. After passing through single-phase step-up transformers and valve-rectifying and smoothing apparatus, the current is supplied at a pressure of 8000 to 10,000 volts to the anodes of the transmitting valves, the alternators being used independently on either transmitter and are not run in parallel. Three single-phase 500-cycle drive-power alternators were supplied by the Electric Construction Company. Each has an output of 1·5 k.V.A., at a pressure of 220 volts, and after passing through single-phase transformers and valve-rectifying and smoothing apparatus, the current from these machines is supplied at a pressure of 2000 volts to the anodes of the valves in the drive or master oscillator panels of the transmitters.

There are three single-phase rectifier filament alternators made by the Electro-dynamic Construction Company, each having an output of 10 k.V.A. at a pressure of 500 volts and a periodicity 300 cycles, and they serve for heating the filaments of the main and drive rectifying valves at a pressure of 11 to 12 volts, after the current has been passed through step-down transformers. These alternators are used independently on either of the transmitters and they are not run in parallel. Three 7½ K.W. magnifier filament generators, made by E. R. and F. Turner, Ltd., of Ipswich, supply direct current at a pressure of 24 volts. One of these generators is used for each transmitter, and supplies the filaments of the oscillator and absorber valves,

and they also charge the batteries which supply current for heating the filaments of the drive or master oscillator valves. Two 12-kilowatt direct-current generators, also made by E. R. and F. Turner, Ltd., supply exciting current at a pressure of 110 volts for the alternators and current for the control and signal relays. The motor alternators and motor generators are capable of supplying the Indian and Australian transmitters at full load, with a main power alternator, a rectifier filament alternator, a drive power alternator, a magnifier filament generator, and a 110-volt generator standing in reserve.

There are four eight-cell 16-volt 420-ampère-hour Hart

FIG. 1—AUSTRALIAN AND INDIAN TRANSMITTERS AT THE GRIMSBY STATION

batteries, two being used alternately on each transmitter for supplying the filament current to the oscillator valves in the No. 3 magnifier panels. Two 400-volt 5-ampère-hour unpasted Hart batteries, each consisting of 220 cells are used for supplying negative voltage to the grids of the magnifier and sub-absorber valves, and two 200-volt and 6-volt portable batteries are employed for working the local heterodyne oscillator listening-in set.

Two sets of valve rectifiers, situated in a railed and screened enclosure in the machinery room, are used to provide the high-tension direct-current anode supplies for each of the valve transmitters, there being one main rectifier and one drive rectifier for each set. The transmitting house contains two transmitters, with control tables between them. Stability of wave length, which is of great importance in short-wave work, necessitates extreme care in the construction of the set, and is obtained by screening, the special system of power supply, and by the use of a master oscillator or drive, which is entirely screened from the other circuits. The transmitter is controlled by the drive, which is a trigger circuit, capable of maintaining the main oscillating circuit on the point of oscillation and of forcing it to oscillate on the drive wave length. The oscillatory circuit of the drive or master oscillator is coupled to another oscillatory circuit, known as No. 3 magnifier, this being a stabilising circuit which acts mainly as a buffer between the drive and the power circuits proper, so that the constancy of the drive can be assured. As in the case of the drive, this No. 3 magnifier is completely screened, and the magnifier is coupled to another oscillatory circuit, known as No. 2 magnifier, which, in turn, is coupled to the grid circuits of No. 1 magnifier, the main power circuit of the set, in which oil-cooled valves are employed. In the main power circuits oil-cooled valves are used in preference to water-cooled valves, as oil reduces the losses to a minimum, and it is also an insulator. The oil used is paraffin with a slight addition of transformer oil to give it colour, so that the flow can be observed.

The transmitter may consist of three or four panels, according to whether one or two distinct wave lengths are to be used. Two wave lengths are employed for the Indian service, and this transmitter has four panels.

Starting from the left, the panel A contains No. 1 magnifier, or the power oscillator, and the high-frequency coupling circuit to the feeders which convey the high-frequency energy to the aerials. The high-frequency circuits of this panel can be quickly changed from the shorter to the longer wave length, or *vice versâ*. The valves used in this case are two, C A T 2 type, Marconi oil-cooled valves, the filaments, which require 18 to 21 volts and a current of 50 ampères per valve, being supplied directly from the 24-volt direct-current motor generator. The filament grid and anode seals of the valves are cooled by air blast. The high-tension direct-current anode supply is given at approximately 8000 to 10,000 volts, and the negative grid biassing pressure is approximately 400 volts. On the upper half of panel B No. 2 magnifier is mounted, and it supplies power to the grids of No. 1 magnifier, which has two M T 9 F Marconi air-cooled valves working with a filament pressure of approximately 17 volts and a current of 12½ ampères per valve. The anode supply to these valves is taken from the 10,000-volt supply main, *viâ* the absorbing resistances and a breaking-down resistance. In the "marking" condition, the high-tension anode pressure is about 5000 volts and the feed 150 milliampères. In the spacing condition these valves oscillate so weakly that No. 1 magnifier fails to oscillate at all. The magnifier grid negative biassing pressure when the set is working is approximately 300 volts. The filaments are fed from the same motor generator as panel A. Magnifier No. 3 occupies the left-hand compartment of the screening box in the B panel and drives the grids of No. 2 magnifier, the high-frequency circuit being the same as in No. 1 and No. 2 magnifiers, except that one valve is replaced by a condenser. The valve is a Marconi air-cooled valve, with a filament voltage of 12·5 and a current of 10 ampères, which is supplied by a special eight-cell battery. The high-tension supply is 1900 or 2000 volts, and the feed about 90 milliampères.

The drive, which occupies the lower right-hand compartment of the screening box in this panel, has the same high tension and filament lighting supply as No. 3 magnifier, the anode voltage and feed current being approximately the same as that of No. 3 magnifier. The valve is a Marconi T 250 valve, and the circuit, which is self-oscillating, drives the grid circuit of No. 3 magnifier. Panel C is identical to panel B, except that it is designed for working on a different wave length, whilst panel D contains the main and sub-absorbing and keying circuits, which divert the high-tension supply by means of two Marconi C A M 2 oil-cooled valves in parallel, through resistances during the spacing periods, and so keep a constant load on the generators. Simultaneously with the shunting of the supply through the absorbing circuits the voltage on No. 2 magnifier anodes is reduced to about 600. The keying current from the high-speed signalling relay fitted on this panel is stepped up to the grids of the C A M 2 valves through two D E T 1 valves in parallel. The filament voltage on the C A M 2 valves is 17–18 and on the D E T 1 valves 6 volts, the filament current being 25 ampères for each of the C A M 2 valves and 2 ampères for each of the D E T 1 valves. The high-tension direct-current anode supply for the C A M 2 valves is obtained from the same source as that for No. 1 magnifier. The grid negative bias to the C A M 2 valves obtained from the dry battery mounted in the panel is approximately 750 to 900 volts, and that to the D E T 1 valves approximately 270 volts. The change from one wave length to another can be accomplished in a period of 7 minutes.

The method of keying is arranged as to keep the load on the power supply constant, for during the spacing period the power is shunted through an equivalent load by means of the panel containing the absorbing valves and resistances, the valves being made conductive or non-conductive as their grids are made positive or negative by the keying relays, the effects of which are stepped-up through a small circuit known as the sub-absorber, directly influenced in its turn by a low current land line relay. When the main absorbing valves are in their conducting state, the energy is mainly absorbed by the mat resistances, which are contained in the absorber house near the transmitting room.

The control tables are in the centre of the transmitting room, but limitations of space will not allow us to deal with the details of the control system. In the absorber house there are three banks of absorber mats for each transmitter, and on a table in the main section of the house there are two Sturtevant blowers for cooling the absorber mats, whilst other Sturtevant blowers supply air for cooling the seals of the oil-cooled valves. The absorber house also contains an oil supply and cooling system, consisting of a tank and three motor-driven centrifugal Rees Roburbo pumps, which pump the oil through underground pipes to the valves in the absorber panel, and the A panel of each transmitter, there being a separate oil-cooling system with its own pump and piping for each transmitter.

The Indian transmitter at the Grimsby Station is arranged for the transmission of signals to India on two wave lengths of approximately 35 m. and 16 m., one wave length being used for night time communication and the other for daylight communication, whilst Australian transmitter transmits signals on a single wave length of approximately 26 m. In the case of the Indian service there are five masts, which are erected in a straight line at right angles to the great circle bearing to India, and these masts carry the vertical aerial and reflector wires, which project a beam along the great circle direct to India. For the Australian service there are only three masts. The aerial and reflector of the Indian service occupy four bays, two for each wave length. Each of the two 35 m. bays has sixteen vertical aerial wires, and thirty-two reflector wires, whilst in each of the 16 m. bays there are twenty-four vertical aerial wires and fifty-four reflector wires. The Australian aerial and reflector system occupies two bays. There are two parallel aerials placed back to back with a single reflector between them. Each of the two parallel aerials has sixteen vertical aerial wires per bay, whilst the reflector, which is common to both aerials, consists of thirty-two vertical wires per bay. The aerial wires have phasing inductances inserted at intervals, and the distance between the aerial wires and between those wires and the reflector wires bears a definite relation to the wave length employed.

High-frequency current from the transmitter is conveyed to the aerials through a feeder system, consisting of two concentric copper tubes. The inner tube is centred

FIG. 2—CORNER OF THE SKEGNESS RECEIVING STATION

in the outer tube by porcelain insulators, spaced at intervals of 3ft. or 4ft. The outer tube, which is earthed, is carried on iron standards driven into the ground. In the design of the feeder system great care was taken to insure mechanical and electrical symmetry, the length of the feeder tube from the transmitter to each individual aerial wire being exactly the same. In the case of the Indian service there are two distinct feeders, one for each wave band, and there are also two distinct feeders for the Australian aerial system, one for each of the two parallel aerials. A special earthing system has also been employed; the

earthing arrangements of the short wave beam system being essentially different from those associated with long wave stations.

The Skegness beam receiving station is built on land situated in the village of Winthorpe, about two miles N.N.W. of Skegness, with open country around it in all directions, so that there is no screening to interfere with the reception of signals. There are many interesting features connected with this station, but we cannot do more than refer very briefly to some of the principal equipment. Power is generated by two 18 horse-power Astor two-cylinder petrol paraffin engines, directly coupled to two Metropolitan-Vickers 10-kilowatt dynamos supplying power at 110 volts to the main switchboard for charging the battery used for lighting the station, and for driving four motor generator sets manufactured by the Crypto Electrical Company. Two of these sets are for charging the four-cell filament batteries and two for charging the 110-cell anode batteries. The masts, receiving aerials, reflectors and feeder system are duplicates of those at the Grimsby transmitting station, with the exception that the feeder tubes are slightly smaller than those at the transmitting station. The receiving masts are erected at right angles to the direction from which the signals are to be received, their exact orientation being—Australian line of masts 17° 17′ W. of true North, and Indian line of masts 1° 30′ East of true North. The effect of the reflector wires is not only to screen the aerial from signals coming from behind, but also to reflect back to the aerial energy received from the front of the system. There are two Marconi short wave beam receivers, which are used for reception from India and Australia.

Returning again to the transmitting station, on the table—shown in Fig. 1—is a sounder and morse key for hand communication, and behind these a standard wave meter for checking the wave length upon which the transmitting station is working. On the left is the Australian transmitter consisting of three panels. At the near end is the No. 1 magnifier panel; in the centre the panels containing No. 2 and No. 3 magnifier and drive, and at the far end the absorber panel. On the right of the picture is the Indian transmitter, which consists of four panels, which are necessary because, as explained above, it is designed to work on two wave lengths, whereas the Australian station only works on one wave length. As in the case of the Australian transmitter, the panels run in the same order from left to right, when facing the transmitter, the additional panel being the second in the middle containing No. 2 and No. 3 magnifier and drive for the second wave length.

A corner of the receiving room at Skegness, with land line connections and high-speed recording instruments, is shown in Fig. 2. On the left there is a key and sounder for communication with the transmitting station and the central radio office. There are also two sets of high-speed recording apparatus with tape pullers, and a Wheatstone transmitter for land line transmission to the central radio office.

Institution of Chemical Engineers.

No. II.*

ON Thursday, March 10th, two sessions were held at Burlington House, one in the afternoon and another in the evening.

In the afternoon Mr. B. D. Porritt, of the Rubber Research Association, read a paper on "Rubber as a Constructional Material in Chemical Engineering." The author spoke, more or less, in general terms, referring briefly to the physical and chemical properties of rubber and the products of which it is a basis. The knowledge of the exact nature of caoutchouc—the essential constituent of rubber and its analogues, gutta-percha and balata—is at present somewhat limited, though the application of the most recent methods of physical research promises soon to supply the key to a problem which has long been a subject of scientific and technical interest. When satisfactorily prepared, raw rubber must be classed as a remarkably durable product, far more so, indeed, than the vulcanised material, as may be judged from the fact that a sample of Para rubber exhibited by Thomas Bolas at the Royal Society of Arts in 1880 is still in perfect condition.

As regards the use of rubber for such purposes as lining vessels, &c., it was pointed out that certain metallic compounds, especially those of copper, exert a pronounced catalytic effect, and when rubber is to be used in conjunction with articles composed of copper or alloys containing copper, it is essential that the contact surfaces should be protected by a coating of tin. The neglect of this precaution has been a fruitful source of trouble in the past, and must continue to be so until the properties of rubber become common property.

The author then considered a few of the more important properties of rubber in relation to the general aspects of chemical and other works practice. Of the problems encountered in a works, that of handling dilute acid liquors is amongst the most difficult, and the corrosive action of such solutions, particularly those containing hydrochloric acid, or unprotected metal, necessitates the use of enamel or the substitution of glass, earthenware or resinous wood for metal containers. Similarly, the effect of steam and acid fumes on leather belting is highly detrimental. Under such conditions, the resistance of rubber to alkalies and dilute acids becomes a property of great technical value. Rubber has its limitations with regard to its resistance to chemical influences. It is readily attacked by chlorine, bromine, ozone and nitric acid, and is slowly carbonised by concentrated sulphuric acid. Its resistance to dilute acid and alkaline liquors is, though, probably unequalled by that of any other material. It is, however, said the author, to its physical rather than to its chemical properties that rubber owes its widespread and varied applications. The first characteristic is that of withstanding deformation without permanent alteration, and no other substance exists which can be stretched to ten times its length and yet return to its original shape practically unchanged.

After mentioning some of the uses to which rubber is put in engineering and chemical engineering practice, reference was made to the power of rubber to resist abrasion, owing partly to its inherent cohesion and partly to its ease of deformation. This property of rubber is attracting increasing attention for a variety of technical uses, and there can be little doubt that the employment of rubber for such purposes will become increasingly common, particularly if more convenient methods can be discovered for uniformly coating chemical plant. There is at present no satisfactory method of exactly defining or of testing resistance to abrasive wear. The factors which determine it most likely vary according to conditions of use, and depend upon the energy of impact and the nature and shape of the abrading surface.

Finally, Dr. Porritt said there is one form of rubber which so far has escaped attention for the reason that its properties of technical interest are specific and not general. The production of the cellular material known as sponge rubber has formed a branch of the industry for many years, but until recently this product has been made with relatively coarse cells, and these purposely ruptured to facilitate the penetration of matter in imitation of the natural article. During recent years, however, a modification in which the cellular structure is much finer, resulting in a very light material possessing an exceptionally low thermal conductivity, has been introduced. This product, Dr. Porritt thinks, undoubtedly possesses distinct possibilities for such purposes as the insulation of cold storage chambers and constant temperature rooms, while its structure should render it useful for isolating delicate instruments from the vibration caused by running machinery.

Mr. Norman Swindin said that, as a chemical engineer, he knew nothing about rubber manufacture, but he wanted a plastic material which could be put on to a tank or other apparatus with unskilled labour. The rubber manufacturers did not like the idea of the work being done in this way, perhaps naturally, but it was essential if rubber was to be used to an increasing extent. Some years ago he had been faced by the problem of lining tanks in connection with the treatment of complex ores in the presence of sulphuric acid, and he had asked for a rubber with which he could line the tanks using unskilled labour. The rubber manufacturers had said that it was impossible, and so he set to work and did it himself. Using uncured rubber and heated tools—which he knew were taboo in the rubber factory—together with a binder, he had effected his purpose, and the linings had lasted for seven years without trouble. Another thing wanted was a rubber solution which would stick to metal and not allow the rubber to peel off. The development of rubber linings would, he said, make possible many processes which were at present lying dormant.

Dr. W. Cullen called attention to the importance of attention being given to the production of rubber materials suitable for use in the tropics, where difficulties were often encountered.

Mr. S. J. Tungay said that chemical engineers were experiencing considerable difficulties in obtaining what they wanted in the way of rubber for various purposes. He, at the moment, was himself faced by peculiar difficulties in obtaining fans, lined with rubber for acid gases, pumps for certain acid liquors, and valves for hydrochloric acid. Those things could all be obtained on the Continent or in America, but in this country chemical engineers were seriously handicapped in that they could not get what they wanted.

Mr. G. B. Jones commented on the fact that hitherto no efforts have been made to standardise rubber in any form. If one ordered rubber on various occasions for the same purpose, there was no guarantee that the same thing would be received twice. As a result, chemical engineers hesitated to use rubber in new directions. It would be interesting to know whether raw rubber had anything like a standard composition, because if it had not that, of course, would be a very great factor in preventing standardisation.

Mr. F. H. Carr (President of the Society of Chemical Industry), after commenting upon the great trouble experienced through the variability in rubber, both as regards its life and freedom from traces of impurities, said he was sorry to say that one of the chemical plant manufacturers in this country would no longer provide his English-made plant covered with English-made rubber. Personally, he had refrained from buying any plant from abroad, but it was a little disconcerting to be told that English plant could not be delivered for several months because it had had to go to Germany to be rubber lined. The English buyer might just as well go to Germany for the plant in the first instance. However, he sympathised with the English plant manufacturer because he was not a rubber manufacturer, and it all showed how necessary it was for British rubber manufacturers to get to know the requirements of chemical engineers.

Mr. Porritt, in his reply, regretted the absence of British rubber manufacturers from the meeting, because all the questions that had been put were of a kind to which they alone could reply. Undoubtedly the ideal of being able to line a tank or other piece of apparatus *in situ* was one to be aimed at. When that was possible, rubber would be available for very many additional purposes. At the moment, however, rubber manufacturers did not like that sort of thing, but were willing to send their own men to a works for the purpose. Standardisation was an extremely difficult problem in connection with rubber, mainly owing to the many sources from which the rubber was obtained, and the many forms in which it was manufactured. If the question were brought to the notice of the British Engineering Standards Association, he had no doubt that that organisation would be willing to take it up.

In the evening Professor F. C. Lea, of Sheffield University, read a paper, entitled "The Effect of Temperature on Some of the Properties of Metals, with particular reference to the 'Limiting Creep Stress.'" The lecturer pointed out that an increasing demand is being made upon metals to resist low and high temperature conditions in parts of plants that may be subjected to stresses, and a knowledge of the behaviour of metals at temperatures ranging from absolute zero to 600 deg. or even 700 deg. Cent. has become imperative. The working of metals at temperatures probably above those values makes it desirable to know how certain properties, particularly those that indicate plasticity, vary at those temperatures so as to determine the temperatures at which they can best be forged or pressed. With many metals experience in the works has expensively determined the temperatures; experimental work in the laboratory can supplement the workshop experience and determine those ranges of temperatures within which brittle phases develop. In internal combustion engines, the properties of the materials and lubrication make necessary the cooling of the working parts in order that they shall not even approximate to the combustion temperature within the cylinders, and more than 30 per cent. of the heat generated may be carried away in the cooling fluid. Any hope of utilising this heat as work can only be realised if metals that are able to work at much higher temperatures than at present are developed, and the production of a successful gas turbine depends very largely upon the possibility of producing metals that will withstand a steady stress, which may be centrifugal stress, under the essential high temperature conditions.

The attempts to gain efficiency in modern steam plant by increasing the temperature of superheat are making demands upon the superheater elements that make it essential to know exactly the behaviour of the materials at the proposed temperatures, and developments in this direction are likely to be very largely controlled, not by consideration of possible gain of efficiencies, but by the behaviour of the materials at high temperatures. A further gain of 5 per cent., or even 10 per cent., may be possible in steam engine plants over and above the best now obtained, but this gain could only be obtained by working at temperatures of, say, 1000 deg. Fah., at which temperatures the metals available have properties that would make the difficulties of working in the superheater and engines very considerably greater than at temperatures of 700 deg. Fah. Problems connected with the cracking of oils, the low-temperature carbonisation of coal and the use of autoclaves at high pressures and temperatures, were of interest to chemical engineers, but whatever success was achieved in the laboratory, experiments could only be economically effective when materials are found that for long periods of time will withstand the exacting temperature conditions required in the industrial process.

Professor Lea then gave some account of the work on this subject which he has done in recent years, and which he described to the Institution of Mechanical Engineers in 1922. One of the physical properties of metals that are important in relation to temperature, is the effect of temperature on the breaking strength of metals. In addition to the breaking stress, the strain produced at any particular stress, and the question whether the magnitude of strain bears a definite and simple relationship to the stress, are equally or more important. Metals at ordinary temperatures are practically elastic, or approximately obey Hooke's law, for definite ranges of stress, but when certain temperatures are exceeded, it is seen that under static stresses Hooke's law is not even approximately obeyed, even for small ranges of stress. On the other hand, metals under rapidly repeated stresses of considerable range behave elastically; in other words, the behaviour of the metal under stress is not independent of time. Above certain temperatures, the rate at which the limiting stress, which causes continuous deformations, changes with temperature is very rapid, and thus local heating not greatly in excess of the mean temperature may be a source of real difficulty. At high temperatures, therefore, the form of the load strain diagram and the effect of time are of the greatest importance.

The lecturer then described in some detail the investigations which have been carried out to determine the properties of metals under stress at temperatures varying from ordinary temperatures to those that are likely to be met with or may be desired in modern plants. The evidence, he said, shows that

* No. I. appeared March 18th.

for each metal there is for each temperature a breaking strength that depends upon the time of loading, and that there is a limiting creep stress for that temperature. At temperatures beyond 350 deg. Cent., the difference between the breaking stress in one hour and the limiting creep stress for steels may be very great, and this is of the greatest importance in all industrial operations involving the use of stressed vessels at high temperatures. At stresses only a little greater than the limiting creep stress, creep may be very slow, and only small movements can be noticed over may days, but if sufficient time is given the rate of creep increases and, finally, very rapidly leads to fracture. For vessels subjected to given stresses, the limiting factor of safety at any stress can be determined when the "limiting creep stress" is known. At ordinary temperatures the "limiting creep stress" only differs from the "breaking stress" by 1 or 2 tons per square inch for most metals, and the material is permanently hardened by the cold work done during the creep.

The form of the load strain diagram for plastic materials depends entirely upon the time taken. The continuous curves often given in the text books are only true when taken fairly quickly. If taken slowly, they consist of a series of steps growing wider and having less and less rise. Hysteresis loops are also dependent upon the time taken in making the loops. When a piece of mild steel yields, the flow may continue for many minutes, providing the load is carefully adjusted, and at higher stress creep may take place for many hours, but finally ceases. The hypothesis of "limiting creep stress" is true for other metals, including the copper alloys with only small percentages of alloying metals, than steel, and it appears to be true also for non-crystalline substances like glass.

There was a short discussion, in which a general appreciation of the value to chemical engineers of the work done by Professor Lea was expressed. Mr. W. T. Griffiths suggested that we are nearing the limit of usefulness of plain carbon steels for high-temperature work, and that there is a certain amount of evidence that we may turn to non-ferrous alloys with a considerable amount of confidence in certain directions.

At the annual general meeting, which was held at the Hotel Victoria, on Friday, March 11th, Sir Archibald Gibb was elected President for the coming year. It was announced that the membership and finances are in a satisfactory position and that several universities are considering arranging for training to fit students for the Institution examination. The London County Council is also considering the establishment of further evening classes for this purpose, the class at the Battersea Polytechnic being full.

Sir Frederic Nathan, the retiring President, then delivered an address on "Some Industrial Developments and the Chemical Engineer." In a somewhat detailed reference to the beet sugar industry—it is anticipated that additional factories will be ready for the 1927–28 campaign at Bardney, King's Lynn and Selby at an estimated cost of over £1,000,000 and capable of treating a further 3000 tons of beet per day whilst the three existing factories at Cantley, Kelham and Colwick are doubling their resources—Sir Frederic expressed a doubt as to whether under existing conditions of raw material and manufacture the industry will be able to pay its way when the subsidy ceases. The decision lay more with the agriculturist than with the chemical engineer, although the reduction of manufacturing costs was a matter for the latter. The farmer could afford to take a lower price for his beet than he is now receiving if he increased both the yield per acre and the possible sugar content, although unfortunately these two do not necessarily go together. On this matter Sir Frederic said the industry was started to some extent here on foreign capital, with a certain amount of foreign technical skill and to a greater extent with foreign plant; it was apparently still dependent on foreign or Dominion technicians for its development.

The subject of motor fuels was next dealt with, particularly as regards the production of alcohol. The Department of Scientific and Industrial Research had arrived at the conclusion that alcohol cannot be made in this country from indigenous raw materials in appreciable quantities or at a price to enable it to be sold in competition with petrol at anything like the present price of the latter. The work that has been going on at the Royal Naval Cordite Factory in Dorset, although throwing considerably more light on the manufacture of alcohol from cellulose of plants by converting it to fermentible sugars either by chemical or bacterial processes had not shown results indicating the possibility of a practical bacterial process, but work on a chemical process for making alcohol from the cellulose of the plant had been carried much further, and it involved certain chemical engineering problems. The laboratory experiments have been confirmed in an intermediate scale unit of 160-gallon capacity. A yield of 20 gallons of alcohol per ton of material, of which about 10 per cent. is acetone, was obtained.

Referring to the coal industry, attention was called to the scope for the chemical engineer in coal utilisation. One of the outstanding directions in which there were possibilities of development in the coke oven industry was, said Sir Frederic, in the economic use of coke oven gas. Most of this gas up to the present had been wasted because if used at all it had been used in direct competition with coal for such purposes as power production, where it could command, on a thermal basis, a price little, if any, better than the coal itself. What must be realised was that coke oven gas was a raw material capable of being profitably employed in a number of modern chemical manufactures. Every day the importance of hydrogen—pure or even slightly impure—in chemical manufacture became more and more obvious. One of the biggest problems for the chemical engineer was that of making hydrogen at a low cost, and coke oven gas provided him with an important starting point for his investigations. Liquefaction of gas on a large scale was receiving the close attention of engineers, but liquefaction was not the only means of separating the constituents of coke oven gas and thus obtaining hydrogen from it. The possibilities of such methods as centrifuging or of selective solubility under pressure could by no means be excluded. Those methods were receiving the attention of competent chemical engineers abroad. The use of hydrogen obtained from coke oven gas had been considered mainly from the point of view of the manufacture of synthetic ammonia and nearly all the plants designed for the manufacture of synthetic ammonia as a by-product from coke oven gas were of foreign origin. The newer developments of the production of synthetic solvents and combustible liquids from mixtures of carbon monoxide and hydrogen, and the possibility of the hydrogenisation of coal, however, offered nearly virgin fields of development compared with the manufacture of synthetic ammonia and gave rise to possibilities for the use of coke oven gas at present wasted. These new processes, however, could only be developed commercially if the hydrogen required could be produced at a considerably cheaper rate than that associated with present methods.

Following the annual general meeting in the morning a further technical session was held in the afternoon, when Mr. F. Heron Rogers read a paper on "The Cross Cracking Process and Plant." It is hardly necessary to mention that the art of cracking oils is the conversion of a petroleum body of a given gravity into other hydrocarbon bodies, some of which are of less gravity and some of which are of greater gravity than the originating mother stock. There are many systems of cracking, the one of which the paper was the subject being due to Drs. Walter and Roy Cross. In it full advantage is taken of what are known as the liquid phase benefits, the oil stock being heated to a point up to or beyond the cracking temperature, in a pump feed pipe, still, or furnace, and allowed to remain at cracking temperature within what is termed a reaction chamber where the incipient state of cracking produced as the oil is heated continues.

From the purely engineering point of view considerable interest attaches to the reaction chamber, which is 45ft. long with a diameter of 3ft. 10in., made from a solid forging. The size of this chamber, coupled with continuous or prolonged use under conditions of high temperature and pressure, raise questions here in England, not only of technical interest, but also questions that were stimulated by the Petroleum Inspection Department on the score of safety. The chamber itself is made from a single ingot of open-hearth steel containing 0·25 per cent. carbon and not over 0·06 per cent. phosphorus. The cast ingot weighs 105 to 110 tons and is pierced, forged hollow and elongated, the two bottle necks at either end being formed towards the end of the operation with the terminal flanges all in one piece. They were manufactured by John Brown and Co., Ltd., of Sheffield, and a considerable amount of research work was undertaken to ascertain the behaviour of mild steel under high pressure. Curves obtained as the result showed that the general characteristic with mild steel was that the actual strength increased as the temperature rose to about 300 deg. Cent. and thereafter decreased seriously. For carbon steels of higher carbon content the relative test results at various ascending temperatures were of the same order. Dr. Hatfield, of the Brown-Firth laboratories, had obtained some later data on creep tests made with the view of studying the slow deformation which resulted with moderately low stressing if the test were performed at elevated temperatures. On a steel of 0·22 per cent. carbon, 0·62 per cent. manganese, and 0·10 per cent. silicon there was a small initial permanent extension, after which there might be a slow steady increase of length. If the applied stress was below a certain value the initial extension might still occur, but was not followed by any further change of length. For such stresses as caused a steady extension the piece went on stretching and ultimately broke after a substantial elongation and "life." The limiting creep stress, *i.e.*, the safe stress which might be applied without causing ultimate fracture, naturally varied with the temperature. For the case mentioned above the safe stress at 750 deg. Fah. was approximately 9·5 tons.

Taking, however, 7 tons as the strength of the steel at 470 deg. Cent., and an internal pressure of 2000 lb. so as to be on the ultra safe side, the wall thickness required was 2.55in. in a cylinder of 40in. Therefore, the 4in. wall provided in the Cross plant provided a very safe margin. The question of sulphur corrosion might be important, but it had been found that by leaving the natural scale upon the interior of the forging damage from that cause was remote. Some American refiners, however, were said to be coating their steel tubes and reaction chambers for cracking process plants with chromium, which, when deposited at a current density of 40 ampères per square foot, left a bright and dense metallic surface that was resistant to sulphur in a very high degree. Each reaction chamber when finished and ready for transit weighed between 42 and 45 tons, and the removal of those vessels from works to site or seaboard was naturally not a matter of light importance.

One such plant as that described in the paper is installed at the works of the Medway Oil Company, and it is estimated that the cost of cracking normal stocks, such as are available in England is between 2¼d. and 2½d. per gallon. As in America, a higher price to the extent of about 2 cents per gallon is obtained over the straight run spirit, it is anticipated that with our small efficient internal combustion engines on motor cars in this country there will be a large demand for the spirit at a premium over straight-run prices. It is claimed that a higher compression ratio can be used without detonation taking place. In other words, the tendency for engines to "knock" with cracked fuels is less.

Sir Frederic Nathan said that the process of cracking had been employed in the United States since 1914, and at the present time, according to the report of the Federal Oil Conservation Board, 31 per cent. of the total gasolene sold in America was cracked.

Dr. W. R. Ormandy deplored the fact that so much research had been carried out upon the creep of steel by those associated with the author, because it had all been done over a much wider range and much more completely in America and Germany years before, in order to investigate the properties of steel to be used under much more onerous conditions, both of temperature and pressure, than in this case. All this work had been done ten times as adequately on nickel-chrome, straight chrome, and vanadium-chrome, and also on molybdenum-chrome steels. He believed it had been carried to even greater lengths in America in order to be able to provide high-pressure large-size steel vessels for pressures up to 4000 lb. per square inch, and temperatures above 500 deg. Cent. The results given in the paper were quite low down in comparison. Steels of the kind he had referred to were obtainable in Germany and America, but not in this country, and in view of the increasing demand for high-pressure apparatus in chemical industry, there should be some co-operation between countries in order to prevent the astonishing waste of time and money, as in the present case.

Mr. C. O. Condrup asked if the Cross plant was made in smaller sizes than 1000 barrels per day. There was room for a smaller unit.

Professor J. W. Hinchley said that having regard to the huge forgings for the reaction chambers in this apparatus, was it not possible to devise some other form of construction?

Mr. Rogers in the course of his reply to the discussion said he had inquired what had been done in Germany on this subject when he was dealing with this matter. Certainly if he could have had Professor Lea's paper at the time it would have saved a great deal of time and expense, but it must be remembered that there was an enormous difference between one steel and another. As a matter of fact, he could find no tests on a 0.25 per cent. carbon steel from a basic hearth converter, which was the type of steel he was wedded to. Therefore he had thought it safer and better to have the tests he had mentioned carried out. As to the manufacture of a smaller unit, he believed Messrs. Cross had made a smaller unit than for 1000 barrels a day, but, on the whole, it was likely that it would not give a cheaper product. As to finding another method of construction for the reaction chamber, he only wished he could, but nothing had come to his notice yet.

The annual dinner was held in the evening, when Sir Herbert Samuel was the principal guest. In the course of the speeches, it was stated by Sir Alexander Gibb (President-elect) that there are now eighty-four engineering and scientific societies, and he expressed a hope—supported by Dr. W. H. Eccles (President of the Institution of Electrical Engineers)—that something might be done to bring them into close co-operation. Only in that way would these institutions have that voice in the affairs of the nation which they ought to have. Sir Arthur Duckham urged closer co-operation between the universities and colleges and the works, suggesting that the works should be thrown open at all times to students and teachers alike, and at the same time technical business men should deliver lectures and set examination papers at the universities and colleges. Then we should get a really effective curriculum for the training of chemical engineers.

A SECOND International Conference on bituminous coal is to be held at the Carnegie Institute of Technology, Pittsburg, U.S.A., in November, 1928, according to an announcement by Dr. Thomas S. Baker, President of the Institute. The Conference will be planned to uncover whatever new information is made available during the coming two years regarding various problems in the use of bituminous coal,

Railway Matters.

A SERIOUS collision occurred at Bhadrak Station on the Bengal-Nagpur Railway on Sunday, March 13th. The Madras mail ran into an engine shunting some wagons. Nine people were killed.

THE improvements in Whitemoor yard, mentioned in this column in our issue of February 4th, will necessitate a capital expenditure of £200,000. The new mechanical locomotive coaling plant will cost £24,400 on capital account.

THE Wimbledon and Sutton intended railway was shown on the map that accompanied our first article of the Morden Extension, which appeared on page 176 of THE ENGINEER for August 13th last. The powers for the purchase of land expire next year, and the Southern Railway is seeking authority in its present Bill for an extension of time. The company has assured the Wimbledon Corporation of its intention to begin the work next year, and to complete it in 1930. The reconstructed station at Wimbledon makes provision for the new line.

A DISTINCT misfortune has happened to the Tilmanstone Colliery in the Kent coalfield. It is raising about 1000 tons a day at a cost of about 24s. per ton. It was hoped to cultivate an export trade, but the Southern Railway's rate is 5s. 9d. per ton. The owner thereupon proposed to install an aerial ropeway, whereby coal could be carried the 6½ miles to Dover for 1s. 9d. per ton. The assent of the Railway and Canal Commission to the scheme was necessary, and when the hearings began there was considerable opposition, but much of it was subsequently withdrawn. One opponent was the Dover Harbour Board, but terms were come to with that body. The Commission was not, however, satisfied with that agreement, and the opposition of the Southern Railway and of the East Kent Light Railway remained. But it was because the scheme was incomplete, and the estimates "inaccurate, illusory and quite impossible" that the court dismissed the application with "real regret." The sequel is that the 900 men employed at the colliery have been given fourteen days' notice to leave.

THE death of Mr. George A. Mountain, former Chief Engineer of the Canadian Railway Commission, took place at Ottawa on February 26th. Mr. Mountain was born in Quebec, and received his technical education in that city. His first important engineering work was done with surveying parties on the Quebec and Lake St. John Railway. Later, he was engaged in the construction of the Quebec graving docks, and the Newfoundland Railway. He was connected with the old Canada Atlantic Railway for twenty-three years, the last ten of which he spent as chief engineer. In 1904 he received his appointment as Chief Engineer of the Board of Railway Commissioners for Canada, which position he held until 1924, when he retired on account of ill-health. During his term of office he supervised much important engineering work, and was recognised everywhere as one of Canada's leading engineers. He was a member of the American Railway Engineering and Maintenance of Ways Association, a Dominion land surveyor and a member of the Royal Astronomical Society for Canada, and for many years he was the President of the Canadian Society of Civil Engineers.

THE coroner's inquest into the death of the twelve passengers killed in the collision at Hull on February 14th, was resumed and concluded on Wednesday, March 16th. The evidence showed that signalman Clarke was instructed to cross the incoming Withernsea train from line B, across line C, into line D as soon as the outgoing Scarborough train had passed on C. To do that, points Nos. 83 and 96 had to be moved. Between these points were some slip points, worked by No. 95, which were facing to trains in road C. As long as signal No. 171 was "off," none of the point levers could be moved, but as soon as signalman Gibson restored the signal, Clarke started to "make the road" for the Withernsea train. Although he did not admit doing so, it is fairly clear that Clarke pulled No. 95 in mistake for No. 96, and so turned the Scarborough train through the slips on to road B, and it met, head on, the Withernsea train. An important point raised was that signal 171 was restored earlier than laid down in Rule 61 (*b*). An explanation for that was offered by the company's officials, and the jury added to their verdict of "Accidental death" a rider that the railway should lay down definite instructions as to the signalmen's discretion in the relaxations of the rule.

THE report of Colonel Sir John Pringle on the fatal collision of November 19th, at Rawmarsh, London, Midland and Scottish Railway, by which nine passengers lost their lives, was issued on March 17th. It may be remembered that a wagon on a train travelling on the down slow line collapsed as it was passing an empty wagon train on the up slow line. One of the drivers on the latter train gave signals of alarm on his whistle, and the other train at once stopped. There was a moving weight of 1270 tons on that train, and the sudden stoppage caused the collapsed wagon to lead to others being derailed, and for the up fast line to be fouled as an express from York to Bristol was approaching. The nearer side of the first three coaches were scraped, but the rear two vehicles had their interior also ripped out. The wagon at fault was privately owned, and Sir John Pringle says that the dominating defects were a breakage existing prior to the accident in the eye-end of the rear intermediate draw bar, where it was attached to the buckle of the buffing springs; the rubber springing in the cradle was perished, and ineffective for the purpose intended; one, at least, of the timber sole-bars was rotted and decayed close to the front headstock, where a face-plate had been bolted on; and there was corrosion of two 1in. through rods, the metal being reduced at places to ¼in. The report recommends that all wagons should be submitted for detailed and careful examination at least once in every ten years of their life. Privately owned wagons should be re-registered at the end of every ten years, without which wagons should not be permitted to run on railway lines. The type of rubber draw springing is not of a type that is recommended, and appears to have been condemned, but not officially, in 1909.

Notes and Memoranda.

THE Canadian National Clay Products Association has decided to standardise bricks at 8in. by 3¾in. by 2¼in.

IT is estimated that the new railway station extensions at Johannesburg, which involve the acquisition of a strip of land belonging to the Wanderers' Club, will cost half a million sterling.

EFFORTS are to be made to develop the Russian mica industry with the help of German capital. The deposits are found in the Murmansk district, and in the Urals. It is hoped to deliver 150,000 poods of crude mica annually to Leningrad, where it will be sorted and cut, giving 15,000 poods of first quality mica, of which half will be best standard sheet mica.

BORON ore has been discovered in the Mojave Desert, 35 miles from Barstow, Cal., where the Pacific Coast Borax Company, San Francisco, has been drilling. A total of fifty-three test holes have been bored to a depth of 600ft., where a deposit of pure calcium borate about 100ft. in thickness, has been found. The proved field is about 5 miles long and more than 3 miles wide.

A SCHEME has been formulated by the salvage department of the Birmingham Corporation for dealing with vegetable refuse so as to produce a powdered fertiliser in a concentrated form. According to the *Chemical Trade Journal and Chemical Engineer*, the scheme for the laying down of plant has been prepared, and will be submitted to the salvage and stables committee for its approval.

RECENT work in the United States has confirmed the value of andalusit—or aluminium silicate mineral—for the production of heat-resisting refractories. Its great property is its resistance to volume deformation. The mineral is ground, mixed with an organic binder, shaped into bricks in wooden or iron moulds, and fixed in a tunnel oven with an 18 Seger cone. The bricks produced are claimed to be especially serviceable in metallurgical furnaces and to withstand a temperature of 1700 deg. Cent. for months.

WORK at the Transatlantic wireless telephony receiving station at Kemback, near Cupar, is progressing. The land line linking the station with the local post office has been completed, and in the power house four dynamos, as well as the engines for driving them, have been placed in position while the large control board and switchboard have been fitted up. Two types of receiving apparatus, one of American and one of British make, are in course of being built at the receiving hut. Dr. Baillie, of the Bell Telephone Company, New York, is in charge of the installation of the American receiving apparatus.

THE growth of the pulp and paper industry in Canada has been remarkable. In ten years the exports of wood, wood products and paper have increased in value from 83,000,000 dols. to 278,000,000 dolrs. The United States consumption of newsprint is over 3,000,000 tons a year, and of it Canada supplies rather more than one-half. Within the next twelve months Canadian mills, now under construction, will be adding about 450,000 tons a year to the present output, and it is estimated that, unless the present rate of consumption expands, there is the possibility of a surplus of newsprint coming on the market at no distant date.

ACCORDING to Mr. H. W. Rowell, who recently gave a lecture before the Birmingham and Midland Section of the Society of Chemical Industry, no really flexible product of phenol-aldehyde resin has been produced commercially because, while the added substances produce flexibility, they reduce melting or softening point, reduce tensile strength or otherwise damage the good properties of the resin. Some samples of quite flexible cloth and paper were, however, shown by Mr. Rowell, which are intended to replace oiled silk and varnished cloth, and which may develop commercially for electrical insulation.

IN his presidential address to the Institution of Chemical Engineers, Sir F. Nathan commented, among other things, on the recovery of by-products in the fishing industry. With reference to fish liver oils the usual practice in this country was, he said, to remove the cod livers on the trawlers and barrel them. On arrival at port these were sold to the East Coast oil factories, and had usually suffered some deterioration before the oil extraction process was taken in hand. To obtain high-quality oil, especially for use in pharmacy, it was essential that it should be prepared from livers as fresh as possible. The German fishermen recognised this, and oil extraction plant was usually installed on their trawlers, with the result that their oil fetched £10 to £12 a ton more than the British fisherman got for his. The matter of a design of a simple and efficient oil extraction plant, and of its installation on board trawlers, was worthy of investigation.

THE American Bureau of Mines has studied gravity methods of concentrating ores and of separating the valuable minerals from the worthless gangue by the use of jigs, tables, or classifiers. These studies have involved the microscopic examination of ores and the making of mineralogical analyses in order to determine the different minerals present, the fineness of the mineral grains, and the distribution of these grains through the mass of an ore. The purpose of the investigation was to develop a series of heavy liquids for use in mineralogical analyses, to get a series of cheap liquids that would enable one to separate by means of the sink-and-float method the heavier mineral particles from the gangue and, if possible, to separate the various minerals from one another. The investigation has consisted largely in a study of the liquids already in use and the development of suitable liquids other than those. The heavy liquids tested in the course of the investigation included bromoform-carbon tetrachloride, acetylene tetrabromide-carbon tetrachloride, carbon tetrabromide-carbon tetrachloride, stannic bromide-carbon tetrachloride, stannic iodide, antimony tribromide, antimony tribromide-bromoform, antimony trichloride, thallous silver nitrate, mercurous nitrate, thallous mercurous nitrate, thallium formate, mercuric chloride-mercuric iodide-antimony trichloride, sodium amalgams, and heavy colloidal solutions.

Miscellanea.

THE extensions of the Durban, Natal, Technical College, which have cost some £50,000, have now been finished and put into service.

THE Government of Nigeria has formulated a programme which involves the yearly construction of 150 miles of railway and 400 miles of roads.

AT Manaos, situated several hundred miles up the river Amazon, a broadcasting station is to be erected having a power of 1 kilowatt and operating on 100 m.

THE World Motor Transport Congress of 1927 is to be held in London in November next, under the auspices of the Society of Motor Manufacturers and Traders.

IT has been decided to postpone the North-East Coast Industries Exhibition at Newcastle until 1929. Over 800 firms have promised £100,000 towards the guarantee fund.

A RICH deposit of platinum, yielding the pure metal to the extent of £40 per ton, has, according to a statement quoted by the Canadian Official Press Bureau, been uncovered on the Aconda Mine property of the Rouyn (Quebec) field.

THE forthcoming meeting of the Illuminating Engineering Society, on March 22nd, is to be devoted to a novel form of discussion. A series of short subjects will be introduced by different authors, each item occupying about ten minutes. The aim in each case will be to state some problem connected with illumination which presents interesting features, or has occasioned exceptional difficulties, and to explain how these difficulties have been met.

A FEW days ago President Alvear opened the new "frigorifico" at the South Dock, Buenos Aires. In his speech he said that such an immense and permanent outlay of British capital signified a community of interests between the frigorifico branch of the meat industry and the cattlemen which revealed the absurdity of the theory of an intent to oppress and discourage producers. Over 1000 guests visited the Blue Star Liner Almeda and the works. The new frigorifico works at the South Dock were erected by the Union Cold Storage Company, and are stated to be the biggest and most up-to-date of the kind in the world. The capacity of the plant is 5000 cattle and 10,000 sheep daily.

WHEN it is a question of schemes involving the expenditure of very large sums of money, states the *Electrical Times*, it is easy to understand that considerable differences in tender prices may occur. It is difficult, however, to see why such extremely wide variations should be found in contracts of quite modest dimensions. For instance, eighteen firms tendered for the electric light installation at the Millfield Institution of the Metropolitan Asylums Board, and whilst the lowest figure quoted was £805, the highest was £3860. Obviously this latter quotation must have been due to some misunderstanding or other, for the next highest was £1325. There were several tenders over £1200, and so a difference of £500 exists between the lowest and the majority average.

GENERAL improvement in basic conditions in world shipping is noted and substantial progress has been made toward recovery, it is declared by officials of the transportation division of the Department of Commerce who have just completed a survey of the world situation. While the supply of tonnage throughout the world is still in excess of demand, the excess has been gradually diminishing, and overseas trade has increased during the past few years, while the output of ships has declined. On January 1st of this year the idle steamships of the world had diminished to about 4,076,000 gross tons, which total was less by 2,010,000 tons than that on July 1st, 1926, and less by 1,769,000 tons than that at the beginning of 1926. The more important reductions during the six months ended January 1st, 1927, were those in the United States and in the United Kingdom—881,000 tons and 744,000 tons respectively.

THE progress of repair work on Lincoln Cathedral has brought to light fresh defects in the structure. In a report to the Executive Committee of the Repair Fund, Mr. R. S. Godfrey, the Cathedral surveyor, says that the south-west tower is in as bad a state as the north-west, and worse in some parts; for 100ft. from the ground old cracks are still widening and new ones are opening. Holes have been found large enough for an arm to be passed through them, and some of the stones are so loose that they can be lifted out of the wall. Reinforcement and grouting will be needed, and extensive repairs are necessary also in the two western bays of the nave. The walls of the latter are buckling at the clerestory level and a reinforced concrete beam along each clerestory will be needed. Crushing and splitting are also going on in the Galilee porch, this being probably accelerated by the traffic on the south side of the Cathedral. The repairs to the north-west tower have been completed for a distance of 20ft. from the top, and the scaffolding has been dismantled for this distance, but much bad stone lower down has yet to be replaced.

THE New Zealand Government, which has been placing heavy orders in the United Kingdom recently for electrical, railway and other plant, is again in the market for six electric locomotives, large quantities of locomotive workshop machinery, and material for the electrification of the railway tunnel between the Port of Lyttelton and Christchurch. The New Zealand High Commissioner in London, Sir James Parr, has reported the receipt of details of these requirements, with the authority to obtain tenders from British manufacturers. The workshop material includes about forty electric drills, welding plants, mechanical hammers, lathes, bull dozers, four electric cranes, and many other machines. In addition to the above, the New Zealand Public Works Department, through the High Commissioner, is seeking to place orders for electrical equipment for a new sub-station at Lyttelton from which the electrification of the Lyttelton tunnel will be operated. The same Department is also in the market for four 500 kilovolt-ampère transformers for the Waikaremoana (Hawke's Bay) power scheme, four 15,000 kilovolt-ampère, seven 1000 kilovolt-ampère, and eleven 750 kilovolt-ampère transformers for the Arapuni (Wellington) scheme.

THE WILSON DAM, BOMBAY

(*For description see page* 317)

GENERAL VIEW FROM NORTH BANK

WATER FOR IRRIGATION BEING LET OUT FROM UPPER SLUICES

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SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST."

The Metallurgist

THE MARCH NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

MARCH 25, 1927.

The Trend of Fuel Injection Practice.

WITH the possible exception of a discussion of the rival merits of the four-stroke and two-stroke cycles or the relative applications of the single-acting and double-acting principles of working, there are few subjects more attractive to the oil engine designer and user than the methods employed for getting the fuel oil into the engine cylinder. The various systems which have now been evolved may for purposes of review be classified into three main groups—airless or mechanical injection, injection with blast air, and ante-chamber injection. These systems, differing in essential principle, have been independently developed, and often have progressed along parallel lines. At the present time there is definite interest being taken in the subject of fuel injection, particularly in those systems in which the use of highly compressed air is entirely dispensed with. Such activity is to be welcomed as an important contribution towards oil engine progress, both on land and at sea.

With the introduction of the Diesel oil engine about the year 1897, greatly increased cylinder pressures were adopted, in order to obtain sufficiently high maximum temperatures to ignite the entering fuel. In order to introduce the fuel into the cylinders against such pressures, the assistance of highly compressed air was sought, and served the double purpose of injecting and spraying the oil. Although some difficulties were encountered in the early days, the air compressor may to-day be looked upon as an entirely reliable auxiliary, owing to the care taken in its design and manufacture, alike by engine builders and compressor makers. With comparatively little experimental work, it was found possible, by using compressed air, to obtain perfectly smokeless combustion over a wide range of fuels and over widely varying engine loads. For this system of fuel injection, it may be claimed that the air entering the cylinder with the fuel gives increased turbulence and combustion is completed early in the stroke. Moreover, that the air so added enables a slightly increased output per cylinder to be obtained. Against these definite advantages we must set, however, the size, weight and cost of the air compressor and its necessary auxiliary appliances, such as air bottles, piping, and valves, and the power required to drive it, which may vary from 8 to 10 per cent. of the output of the engine. Another factor which is important is the cooling effect of the blast air when starting, which sometimes leads to delayed and incomplete combustion in slow-running marine oil engines, especially during manœuvring. With the object of overcoming some of these disadvantages, considerable ingenuity has been displayed in evolving systems of airless injection, in which the fuel is sprayed directly into the cylinder by mechanical means. Considerable experimental work was required to develop these systems, but the results obtained have been very satisfactory. The good mechanical efficiencies and low fuel consumption of the airless injection engines were a marked feature of the recently concluded marine oil engine trials. A difficulty which is often met with in multi-cylinder airless injection engines is the problem of dividing the load equally over all the cylinders. In practice, pyrometers placed in the exhaust outlets are often employed for tuning up and adjusting the cylinder load on four-stroke cycle engines. With two-stroke cycle, however, such a procedure is not possible, and some means of testing the amount of fuel delivered to any cylinder would seem to be necessary. If the results obtained from airless injection engines are studied, it will be clearly seen that a wide range of fuels can be employed, and that very low fuel consumptions may be obtained; but that system, it is contended, is at present hardly so flexible as regards the use of heavy fuel oils as is the system employing blast injection air. The other type of fuel injection to which we have referred comes from the Continent, and is that in which a subsidiary or ante-chamber adjacent to the working cylinder is employed. Just before the end of the compression stroke a few drops of fuel are injected into an ante-chamber and are there ignited. The combustion of this fuel provides the energy required to inject the main charge through a spray nozzle into the working cylinder. By such means injection is effected with considerable turbulence and possibly with rapid flame propagation. The system has found useful application for both horizontal and vertical engines of medium and small powers.

The position at the moment is a very interesting one. The air injection method is still adhered to by many standard makers of marine and land engines, and it is quite likely that no sudden change will take place. On the other hand, there is an increase in the number of engines which are working with airless injection, and which are showing excellent results, the fuel consumptions being in many cases well below those obtained with engines working with air injection. It is now generally known that in order to obtain comparative results with the two systems, similar ships engined with the same type of machinery, but fitted with different types of fuel injection, are undergoing prolonged tests at sea, under commercial conditions, and the results of these trials will be awaited with no little interest. Airless injection is also to be tried on two large-power double-acting marine oil engines of recent British design. As we see it, the trend of fuel injection practice is undoubtedly in the direction of further applications of the airless system, mainly on the score of increased simplicity and reduction in cost. A factor which is in favour of this development is that it is now regarded as standard practice to fit machinery for the centrifugal treatment of fuel oil on practically all motor vessels. It is difficult to forecast changes which may take place in the quality of oil fuels, but with the probable increased application of cracking processes to the heavy oils of fuel quality, in order to raise their yield of petrol and the lighter fractions, it does seem quite likely that in the future oil engine builders and users may be called upon to make use of heavier fuel oils. Any far-reaching development of low-temperature carbonisation processes or the winning of oil direct from coal would have a similar result, in which case the experience gained during the war period with pilot injection systems will again prove valuable.

Ciment Fondu Concrete.

OUR contemporary, *Le Génie Civil*, published, in a recent issue, an article entitled "Observations sur une Maladie des Bétons de Ciment Fondu." The article is from the pens of MM. E. Freyssinet and A. Coyne, the former a late engineer and the latter a present engineer of the Ponts et Chaussées, both of them well known men. They were led to investigate the matter they discuss by reason of certain anomalies which were noticed in August last year in the behaviour of concrete made with Ciment Fondu and used in the construction of a

bridge over the Elorn at Plougastel, near Brest. Here and there in the structure and in other concrete works in the neighbourhood, also made with Ciment Fondu, there appeared patches which differed widely both in colour and strength from the sound concrete immediately surrounding them, and the investigators ascertained that these differences in colour made themselves manifest immediately after the concrete was mixed. The concrete that was sound took on, after it set, a dark grey colour lightly tinted with blue or brown, the grey-brown predominating after the concrete had been for some time exposed to the atmosphere. It became very hard after several days, and forty-eight hours after setting a concrete made with 400 kilos. of the cement to the cubic metre could be counted on to have a crushing strength of from 250 to 300 kilos. per square centimetre with blocks measuring 20 cm. cube. On being struck with a hammer the concrete gave out a clear ring, and on being broken the fracture was clear and bold. The defective concrete might show two colours :—(*a*) a greenish blue-black, which was unstable when exposed to the air, and (*b*) a reddish-yellow or dull earthy colour, which, when dry, turned to a clear earthy grey. The sound given out under a hammer blow was dull, and the fracture was coarse and rough. Samples of these bad parts were cut out and were found to be very inferior in strength to the sound concrete and to vary considerably one from the other. The crushing strength at ninety days was, at most, 100 to 150 kilos. per square centimetre, though a slight increase in strength was observable when the samples, which felt moist when they were first cut out of the mass, had dried as the result of exposure for some time to the air.

In the course of their investigations MM. Freyssinet and Coyne satisfied themselves beyond any doubt that the defective parts were not the result of errors made on the site, such as the use of wrong proportions or different aggregates, nor by insufficiency or excess of water or the use of dirty tools. Nor were they due to the quality of the sand and gravel used. Moreover, it was conclusively proved that materials taken from the same heaps had given both sound and defective concrete, and the cement itself was found to be beyond suspicion. They then proceeded to carry out some tests on concrete made by themselves. They chose three sacks from a number of the same batch which had given abnormal results and used for their concrete an average of the contents of these sacks. The concrete they mixed was composed of 400 kilos. of cement to 700 litres of gravel, 250 litres of sharp quartzy sand and 250 litres of sea sand from the dunes. They had ascertained in the course of their inquiries that defective patches had been experienced when both fresh and sea water had been used for gauging, and that some, at any rate, had occurred when the concrete was made in very hot weather. The results of their tests were most enlightening. They are given in the article in the form of a table and also in diagrams. They first of all tried a series of blocks, all of them save one measuring 20 cm. along each edge. Six blocks were made at ordinary temperature with fresh water, and at twenty-six hours they gave an average crushing strength of 367 kilos. per square centimetre. Eight blocks made with sea water at ordinary temperature gave, on the other hand, an average of only 212 kilos. per square centimetre at twenty-six hours. Then six blocks which were made with fresh water warmed to 35 deg. Cent.—95 deg. Fah.—the temperature of the atmosphere being 20 deg. Cent. and that of the cement and aggregate 21 deg. Cent., were tried. The result was an average crushing strength of 348 kilos. per square centimetre, which, though less than that of the blocks made with fresh water at ordinary temperatures, was not greatly so. Six blocks made with sea water at 35 deg. Cent. gave an average almost identical with that given by the eight sea-water blocks gauged at ordinary temperatures, namely, 214 kilos. per square centimetre, as compared with 212. Raising the temperature of the gauging water still higher, however, had an astonishing effect. The results with three blocks made with fresh water and three with sea water are given, the temperature of the concrete after gauging being 42 deg. and 43 deg. Cent. respectively. The three fresh-water blocks gave strengths of 122, 77, and 107, or an average of 102 kilos. per square centimetre, and the three sea-water blocks 61, 52, and 37, or an average of 50 kilos. per square centimetre. These and other experiments satisfied the experimenters :—(*a*) That concrete or mortar made with Ciment Fondu experiences a very considerable fall in strength accompanied by the characteristic colouration already mentioned if the circumstances are such that the temperature after gauging can rise above a certain minimum, as, for example, when the materials are strongly heated by the sun's rays. There may, however, be an increase of strength later. (*b*) That when sea water is used for gauging there is always a falling off in strength of some 50 per cent. as compared with concrete gauged with fresh water. Do these discoveries, then, indicate that Ciment Fondu should be condemned, ask MM. Freyssinet and Coyne. And the reply they give is that they do not think so. The day after a Ciment Fondu concrete has set the colour of the cement will always indicate whether it is good or not, which, they add, is not always so with Portland cement concrete. If the colour is fresh grey-blue or grey-brown, then the concrete is good and can be depended upon. If it has not got that colour, then it should be cut out and replaced, and, since it has not hardened to the extent of sound concrete, that operation is not difficult. They recommend, however, that, in addition to the ordinary laboratory tests to which cement is subjected, Ciment Fondu should have applied to it a series of additional tests to ascertain the variation of temperature during setting under different conditions of initial temperature, quantity of gauging water, mass, &c. These tests should be carried out under conditions sensibly less favourable than those likely to be experienced in the work for which the concrete is intended. It is, they add, essential to avoid employing Ciment Fondu when the Ciment, or the sand, gravel, water or shuttering can be strongly heated. Furthermore, rises of temperature and drying during the setting period should be fought against ; an ample quantity of gauging water should be used and the concrete should be kept very wet while it is setting. If these conditions are attended to, then the employment of Ciment Fondu will, they assert, give security of the same order as that offered by Portland cement—which is itself affected by certain hurtful influences—and will enable the user to benefit, without any risk, by the immense advantages which the aluminous cement offers for marine and other work as much by its resistance to decomposition as by its quick-hardening qualities.

The case presented by MM. Freyssinet and Coyne is of great importance to civil engineers and contractors in all parts of the world, and particularly to those engaged upon works in tropical or hot climates. In recent years the employment of Ciment Fondu has extended considerably. It has qualities which render it exceptionally suitable for certain classes of work. Amongst these qualities that which takes foremost place it its property of rapid hardening, but its remarkable strength must not be overlooked. It has perhaps been more largely employed in France, the land of its origin, than in this country, but we believe this to be the first time, either there or here, that attention has been publicly called to this phenomenon. It is admittedly inadvisable to accept the results of a single investigation, and without questioning for one moment the care and experience with which the malady, as they call it, was examined by MM. Freyssinet and Coyne, we say without hesitation that a further research into the problem is imperatively necessary. The French investigators have performed a valuable service in indicating that certain precautions must be observed in the use of Ciment Fondu. That, of course, is a common experience with all structural materials, and is no more derogatory of Ciment Fondu than, let us say, of steel or bronze. But just as close investigations have been made into the conditions which must exist in the use of metals, so, it would seem, should they be made into this phenomenon associated with the effect of heat upon a material which, owing to remarkable properties, is coming into more extended use. Ordinarily, in this country, injurious conditions of temperature are likely to be encountered rarely, but the case is different in tropical lands, and an exact definition of the circumstances in which Ciment Fondu loses its qualities, and the precautions which must be observed in order to prevent their incidence, is, we submit, very desirable, both in the interests of engineers and of that valuable material itself.

Institution of Mechanical Engineers.

NORTH-WESTERN BRANCH.

A VERY largely attended meeting of the North-Western Branch of the Institution of Mechanical Engineers was held at the College of Technology, Manchester, on Thursday, 17th inst., when Captain C. H. Kuhne presented his paper on "The Development of Mechanical Vehicles for General Load-carrying Duty in the Army," with special reference to the W.D. type rigid-frame six-wheeled lorry. The paper, of which we complete a reprint to-day in another column, was illustrated by several lantern slides and a cinematograph film.

In calling upon the lecturer to give his paper, the chairman, Mr. Harold Massey, said that the subject was of very general interest, and Captain Kuhne, who knew a great deal about it, had been connected with the movement during the war, and had been one of the moving spirits—if not *the* moving spirit—in the development which had taken place.

In the discussion which followed, Captain C. Jackson, General Manager of the Oldham Corporation Tramways, said that he was particularly interested in the six-wheeler from the commercial, and not from the military point of view. The tendency in the passenger world seemed to be to get a large-capacity vehicle seating something like fifty-four passengers. On a four-wheel chassis, they got a load in the neighbourhood of 5½ tons. It had been found in practice that such vehicles with solid tires set up a good deal of road vibration, and much of that road vibration was transmitted to the vehicle itself, so that the speed had had to be reduced, and a reduction in speed meant also a loss in revenue per mile. An attempt had been made to mount those vehicles on pneumatic tires, but they had got as big a weight as they could carry, and they wanted a bigger vehicle still. The only way was to get a six-wheeler. In Oldham they had operated some 50,000 miles on those six-wheeler machines, and they were doing very well. At the present time they had a design in front of the Ministry of Transport for a seventy-two-seater double-deck motor omnibus, and in no case would the axle load exceed 4 tons, and it could be mounted on pneumatic tires. His own experience would lead him to stress the author's remarks with respect to the lateral strength required in the vehicles' springs. On the commercial type of machine, the tires were only single, and they did not affect the torque tube shown in the slide. He—Captain Jackson—had had the privilege of operating the type of vehicle described by the author on page 13. Apart from occasional puncturing of the tires, they had had no trouble, even during the recent winter. It was only with six-wheel machines that they could run over the snow without having previously cleared the road, and they had run first thing in the morning without any trouble. The author had referred on page 27 to the difficulty of getting adequate body space for commercial needs, "without having either excessive rear overhang or too long wheel base (with poor belly clearance), or a faulty load distribution over the axles." That was a very real problem. It meant that very long seats had to be fitted in the vehicle on each side, and full use could not be made of the vehicle space. On page 28 the author stated that "the initial cost of the [six-wheel] vehicle is reasonable," but unless they could utilise the six-wheeler to give decent accommodation, it was doubtful whether it was reasonable. There was no doubt that the six-wheel vehicle did provide increased comfort to the passenger. The movement imparted to the frame was noticeably less than in the four-wheeler, and from a public point of view was more satisfactory. The author had suggested that with a six-wheeler the power saved was not inconsiderable. While it was early to give accurate data, operating under the same conditions, a considerable improvement, amounting to 15 or 20 per cent., had been noticed over a four-wheel machine. Their six-wheelers in Oldham had cost them £250 more each than the four-wheelers.

Mr. Liardet, of Leyland Motors, Ltd., said that he did not think that anyone would dispute the fact that the vehicles which had been described were, from the military point of view, excellent. It was different, however, when they came to consider six-wheel vehicles for commercial purposes, *i.e.*, commercial purposes confined to this country, because if the Government were going to subsidise those vehicles, they would want them in this country rather than abroad. In the first place, he thought a six-wheeler was only justified by its ability to carry greater loads. On roads such as they had in England, there was no advantage in getting extra adhesive power or extra torque, but to reduce the weight per axle and to get a bigger load must be advantageous. The type of vehicle described was, in his opinion, quite different from that which was necessary for commercial purposes. Captain Jackson had told them that his vehicles cost £250 more than the four-wheelers. The reason for the extra cost was that they could not use entirely standard units for the manufacture of a six-wheel vehicle. Certain modifications to the axles and the springs which, in his opinion, would be absolutely unnecessary to introduce into an ordinary commercial vehicle, were required. He maintained that, with a six-wheeled vehicle, taxation would be higher. The Government based taxation on the weight of the vehicle. If they added another axle, they increased the weight, and therefore increased the taxation. Therefore the Government would have to offer very great inducement to the commercial user to purchase that type of vehicle. He added that so far as his firm was concerned, it was most anxious and desirous to assist the War Office

in every possible way, but it did see that difficulty, and he would be much obliged to the author if he could tell them how to get over it.

Mr. Bostock said that the whole secret of the success lay not only in the design of the axles, but in connection with the gearing. On the Continent, many people were favouring bevel gear. He was very glad to know the success that had been attained with worm gearing. They heard a lot at the present time about tramways being obsolete. It might be interesting to know that in some places where they had a large amount of capital laid out in permanent way, and could not afford to scrap the trams, they were considering using the principles of six-wheel machines, and having really what they might call two complete axles at each end, so that all eight wheels were being driven by means of worm gear. He added that as the axles moved up and down there appeared to be a tendency for the wheels to oscillate or to give a certain angular movement. With the tramway, that was rather serious.

Captain Kuhne, in reply, said that Captain Jackson had told them that he was running some of the six-wheel vehicles with success, and that the cost of running them had effected a saving of about 20 per cent. He had also said that those vehicles cost £250 more than the equivalent four-wheel vehicles. He—Captain Kuhne—understood that those six-wheelers had a larger carrying capacity than the four-wheelers, and therefore it seemed to him that one thing was tending to answer the other. They had a vehicle with a larger carrying capacity and a better passenger mileage per gallon. When they turned to the question of depreciation, the point he had not been able to emphasise was that, owing to the easier riding of the six-wheel vehicle, the movement imparted to the chassis, when it went over obstacles, was only half the height of the obstacle in each case. Another point was that it was not only that the rise of the chassis when passing over an obstacle was less, but the value of the impact reaction was much reduced. In the first place, the six-wheeler enabled them to use pneumatic tires. Having got that, there was the advantage of the reduced impact of the pneumatic tire, as compared with the solid tire; but there was still another point, and that was that when one of those wheels—say, the leading driving wheel at one side—struck an obstruction, the impact that took place was immediately shared by the other driving wheel on the same side of the vehicle. The difference in impact between the solid tired wheel and the pneumatic tired wheel ranged from 4 to 7 to 1; and he would suggest to Captain Jackson that the saving in running six-wheeled vehicles, both in wear and tear due to load vibration, and as regarded reduced fuel consumption, was going to offset the extra cost quite apart from the fact that the vehicles were of greater carrying capacity. The depreciation was bound to be less when the vehicle was shaken about less, and they were carrying more passengers per mile of fuel used. It was early as yet to be able to give a comprehensive running figure for six-wheeled vehicles, but he did know that vehicles which were carrying 4-ton loads over distances of 8000 miles and carrying on the return journey loads between 2 and 3 tons, with a certain amount of running in London thrown in, were doing that work with a petrol consumption in the hands of the commercial user of 9¾ miles to the gallon of petrol. He had yet to be shown an ordinary solid-tired lorry that would give that figure. Their own experience was that as far as useful tons per mile per gallon were concerned, that type of vehicle was a little more economical in actual fuel consumption, quite apart from the wear and tear, than the equivalent four-wheel lorries. Mr. Bostock had referred to the worm gears, and he—Captain Kuhne—was happy to say that, although at the beginning when they had started the work they had been almost persuaded by an expert that they would need a differential between the two axles, they had had no trouble with the worm drives of any of those machines, which said a lot for the gears themselves. The author concluded by saying, with regard to the question of the angular displacement of the wheels when articulation of the wheels was taking place, raised by Mr. Bostock, that he had tried to make it clear that when the axles moved relatively to one another, no change in angular velocity took place. Except for the fact that the axles naturally moved about a point, no other change took place at all. There was no change in the angular velocity.

What is Electricity?*

WHEN we read that "in the beginning God created the heaven and the earth," we know within the limits of human knowledge that the first thing made was electricity, for recent research has shown that the atoms of the universe are nothing more than spinning groups of electrical charges, minute planetary systems, each with a mass of positive charge as a sun or nucleus about which electrons or units of negative charge revolve in orbits, each step of which corresponds to a line in the atomic spectrum, visible or invisible. With slight modifications Newton's great law of gravitation holds for the farthest stellar systems of immense magnitude and for the smallest atoms. As the telescope tells us that the vast interplanetary regions are empty of matter, so these spaces find their counterpart in the hollow interior of the atom, swept clear of intruding electric charges by the outer electrons revolving in their orbits a hundred million times a second, giving out light under certain conditions, oscillating at the same high frequency. Light is an electrical phenomenon, visible electrical radiation, requiring an oscillation of electrical charge to produce it, and a receiver, such as the eye, to observe and record it. Since light of a kind identical with that we can make has been received from atomic vibrations in stars so far distant that it has taken 140 million years travelling at a speed of 186,000 million miles a second to reach us, it can surely be inferred that electricity in the most distant parts of the universe is the same as that of which this world is made.

Although the nature of electricity as a dual entity may still be in doubt, a good deal is known about it. In the first place, it is a thing, or, as Herschel said of the atom, a manufactured article, not in the strict sense material, but a kind of sub-matter. The simplest atom of matter, that of hydrogen, has in its structure one of each of the two fundamental electric charges which were first called positive and negative by Benjamin Franklin; but these titles are merely names which tell us nothing. The charges might better be called large and small, heavy and light, or right and left-handed electricity, because in those ways they differ, though electrically they are equal. The fact that, unlike kinds of electricity attract while like kinds repel, gave rise to these names for indicating opposite properties, but the charges have in their electro-magnetic behaviour directly opposite characters, and for that reason only can they be said to be opposite in sign.

There are nearly twenty-five billion electrons to the inch. Protons are still smaller, but they are 1850 times heavier than electrons. In order to make the electrons in a drop of water just visible to the naked eye it would be necessary to magnify it to 100 times the volume of the earth, and if we could place all the protons in the earth together so that no hollow cavity existed, they could be packed into a handbag, which would then weigh 6000 trillion tons. The number of protons and electrons in even a small portion of matter scarcely visible is too vast to be grasped by the human mind, and are reckoned in thousands of quadrillions. When we ask for a pound of bread or of butter or tea we are really asking for a pound of electricity in the form of these commodities.

There are known to be ninety-two possible atomic elements of matter, a few of which still have to be discovered. The most wonderful feature of these is that each of them normally contains equal numbers of positive and negative units of electricity, and to account for this equality both must have been made simultaneously by the same act, a definite creation requiring immense work to be done. The electricity in the universe is an incredibly vast store of energy; there is in fact enough energy in one pound weight to raise a hundred million tons of cold water to boiling point or to give sixteen thousand million horse-power for one hour, the proof of this statement being one of the most solid achievements of the theory of relativity.

Electricity must be made from the ether, for so far as is known there is nothing else to make it from. Since in the formation of the charges work is done, and as that can only be by compression, tension or twist, it is necessary to find which of these was first used in making them. The earth moves through the ether without resistance and the planets do not appear to be in the least affected by their motion through it. It is therefore impossible to apply force to it by ordinary matter, but it can be twisted by electricity in motion, for around every electric current there is a magnetic field right-handed about a positive charge and left-handed about a negative charge. A magnetic field is a circulation in the ether resembling a fluid spin or vortex, and this can be shown by a discharge in a vacuum tube.

There is only one known mechanism in which a movement forward is accompanied by a rotation around the line of motion, and that is a screw, which when turned advances or when caused to advance rotates. By their electro-magnetic behaviour there is the strongest evidence that protons and electrons have the properties of screws of opposite sign, right and left-handed respectively. When the motion stops the twist relaxes and the magnetic field ceases. The simplest screw element that can be made is a half-turn loop or kink on an elastic cord, such a loop being known as an elastica.

The ether is known to be fine grained—that is, to have a structure. This was first suggested by Lord Kelvin to be that of a vortex sponge, a perfect tangle of extremely small hollow threads of the fluid ether spinning round their centre lines. This view has been supported by very strong evidence, and it is now suggested that the screw forms of protons and electrons are simply permanent loops or vortex threads of such an ether. They are permanent for the two sides of the loop and are held together by their common circulation, just as an electric loop is held together at the crossing point by its magnetic field. The two cases are identical.

Suppose a great spin were given to such an ether, what would happen? Half of its spinning thread would be spun tighter and the other half untwisted. But when a thread is twisted sufficiently a loop forms right or left handed, according to the relative direction of the original spin of the filament and of the superposed twist. Such loops on a vortex thread are permanent and they have all the properties of the electric charges. When moved they produce circulation around their line of advance, in this way accounting for the magnetic field around a moving charge, and since the loops are right and left-handed, their magnetic fields should be, as they are, opposite in sign. But the loop twisted tighter should be smaller than that opened out and therefore one electric charge should be smaller than the other, as it is, for the proton is smaller than the electron. The smaller should offer more resistance to motion than the larger, for it is more difficult to get a fluid stream through a small orifice than through a large one. The proton is much more difficult to move than the electron, being 1850 more massive.

There is evidence that the ether is not an incompressible fluid and that its filaments are not infinitely long, but short and varying in section, though each in itself has the same circulation, for the protons and electrons all have the same electrical charge; that is, have the same strength or associated movement around their centre lines. These filaments may be imagined to be, as it were, trumpet shaped at each end. When two filaments, on which permanent loops have been formed, approach, their ends which have the same direction of circulation coalesce and the two parts when joined form an atom or part of an atom. If there are only two, one of each, we have a hydrogen atom. The next highest, the helium atom, is much more complex and the scale of complexity rises rapidly, according to clearly defined and known laws.

The ether itself is an insulator—that is to say, it contains no free isolated electric charges—but it transmits electric waves by the rocking motion, communicated to its filaments by the oscillation of an electric charge in an atom, in which case the waves are short, or by electrical oscillations on conductors forming, for example, the aerials of radio systems, when the waves may be miles long. In every case of X-rays, light or radio the mechanism and velocity of transmission are the same. A change in motion drags the adjacent filaments around as it passes and these at once relax to their old position, but by their motion, having magnetic energy, they overshoot and oscillate, handing on their motion to the next filaments at the speed of light. To have this high frequency the ether behaves, because of its intrinsic spinning motion, as a very rigid medium with an extremely high coefficient of elasticity.

Electricity in motion produces magnetism. Since all matter is nothing but electricity and contains equal quantities of each kind, a piece of matter moved through space does not give rise to any external magnetic effect. The two kinds counteract one another, but when the motion takes place in a magnetic field the resultant force on all the positive charges which go to form matter is in one direction sideways to the motion, that on the negative charges being in the reverse direction. The charges therefore separate a little and the body is said to be polarised. If the body is an insulator, the polarisation is proportional to the velocity of the movement, and if a conductor it is also proportional, but only one charge, *i.e.*, the negative, can move. All the positive charge is anchored in the nuclei of atoms and cannot move bodily. But in metals and similar substances a great number of negative charges are free to move about like molecules in a stream, and when such a body is moved in a magnetic field there is a piling up of the negative charge at one end of the conductor, given what is called the open circuit voltage. When the ends of the conductor are joined a stream of electrons passes through the external circuit and back into the wire forming a completely closed path, the motion of the conductor through the magnetic field causing it to act as an electron pump or dynamo. The work done in causing the electric charges to stream along in this way is not dissipated in the machine, but is handed on to the external circuit to light lamps, drive motors, and so forth.

* Abstract of Faraday lecture delivered by Professor W. M. Thornton before the Institution of Electrical Engineers on March 17th.

SIXTY YEARS AGO.

SIXTY years ago, Snider, the American inventor, who had devised a satisfactory means of converting our muzzle-loading Enfield rifles into breech-loaders, had just died under circumstances which many held reflected strongly on the liberality, if not the humanity, of the British Government. If, however, our authorities treated him parsimoniously, they did not fail to adopt his idea. Large numbers of muzzle-loaders were coverted on the Snider principle, the work being pushed forward expeditiously under the influence of the object lesson provided by the Germans with their needle guns in the campaign against Austria in 1866. In 1867 disturbances in Canada, preceding the union of the British North American Provinces, which was then about to take place, led to a sudden and enormous demand on the small arms factories engaged on the conversion of the old rifles and the manufacture of the ammunition required for the new pattern. The pressure of the demand would appear to have been responsible for various defects of manufacture, which many people were not slow to seize upon as evidence of inherent defects in the system which Snider had developed. The experimental converted rifles and the ammunition made for them had been carefully made by hand. Tests revealed them as satisfactory. But when the development reached what we would now call the "production" stage there was a marked falling off. According to a note in our issue of March 22nd, 1867, sixty pattern rifles with hand-made ammunition showed an average deviation of the bullet from its mark of only 1ft. at 500 yards range, as against more than 18in. with the muzzle-loading Enfield. At 1000 yards' range the average deviation was 5ft. 8in., as compared with 7ft. 11in. These results, we recorded, were as unexpected as they were pleasing. In addition to increased accuracy, the Snider rifle was found to possess the important military property of a lower trajectory. But when a number of "production" rifles were tested the shooting was found to be wild in the extreme, many of the shots falling short of the target and others going no one knew where. A new pattern of ammunition was tried. The accuracy of shooting was restored, but sacrifices had to be made in the weight of the bullet, and in the matter of the trajectory, which now became considerably greater than with the muzzle-loader. The great object of the conversion, rapidity of fire, had, however, been achieved, and it was argued that with improved methods for the manufacture of the ammunition the Snider breech-loader might become a weapon of a very useful kind. It was not, however, regarded as promising a perfect solution of the problem. The authorities had adopted the conversion system as a matter of urgency and expediency, but they were not content with the results and were organising a competition for improved breech-loading rifles and ammunition.

CONTRACTS have been signed for the growing of 8160 acres of beet for the second Anglo-Scottish Beet Sugar Corporation Factory at Cupar, and the directors will give formal sanction for doubling the capacity of the factory from 500 tons of beet to 1000 tons per day.

The Development of Mechanical Vehicles for General Load-carrying Duty in the Army.*

WITH SPECIAL REFERENCE TO THE W.D. TYPE RIGID-FRAME SIX-WHEELED LORRY.

By CAPTAIN C. H. KUHNE, D.S.O., O.B.E., R.A.S.C., Associate Member.

(*Concluded from page* 308.)

W.D. Specification and Civil Co-operation.—The W.D. visualises three sizes of rigid-frame load-carrying six-wheelers to meet its various needs, and two of these sizes are now in production, viz.:—

"Light," to carry useful load of 30 cwt. on the road, 20 cwt. across country.

"Medium," to carry useful load of 60 cwt. on the road, 40 cwt. across country.

The "Heavy" is the third size and is as yet unspecified. A specification has been prepared for the "Medium" size, approved by the M.T. Advisory Board of the War Office. A specification will be prepared for the "Light" type also.

It is of importance to emphasise the loads mentioned above are the official W.D. useful loads and do not necessarily represent the full useful loads which vehicles of different makes now in production are quite capable of dealing with commercially on the roads in this country.

Every effort has been made to draw up the specifications on a broad basis. Certain items of construction and performance which are considered essential for W.D. needs are insisted upon, but, apart from this, considerable latitude is permitted to the manufacturer so that he may make his own interpretation of the requirements of the user. For example, the W.D. considers that in the case of the "medium" type six-wheeler the ratio of the useful load carried (commercial, on home roads) to the chassis weight should be from 1·2 to 1·4. But for the purpose of acceptance under the specification for this size of vehicle the W.D. will consider vehicles in which the ratio of the official W.D. useful load of 3 tons to the chassis weight is not less than 0·92. Standards (B.E.S.A., &c.) are specified as far as possible.

The W.D. is anxious to see on the road and in commercial hands large numbers of vehicles of the same types which the Army uses in peace, and which can be taken into the service of the Army in the unfortunate event of future mobilisation. This is but one item in the general scheme of military defence, under which the Regular Army, training intensively and working as an Empire police force in peace, becomes the essential highly trained and equipped nucleus of the nation under arms in time of emergency. The term "nation under arms" presupposes free expression of will, and also co-operation. Thus it is by close co-operation with civilian engineers, the manufacturers and the users that it is hoped to obtain that reserve of suitable vehicles which is so important a feature of any mobilisation plan. It is hoped, at the same time, that the research and experimental work carried out by the Army may help to open up new and lucrative developments to the benefit of the industry and the Empire.

FIG. 12—General Lay-out of Chassis (Guy "Medium")

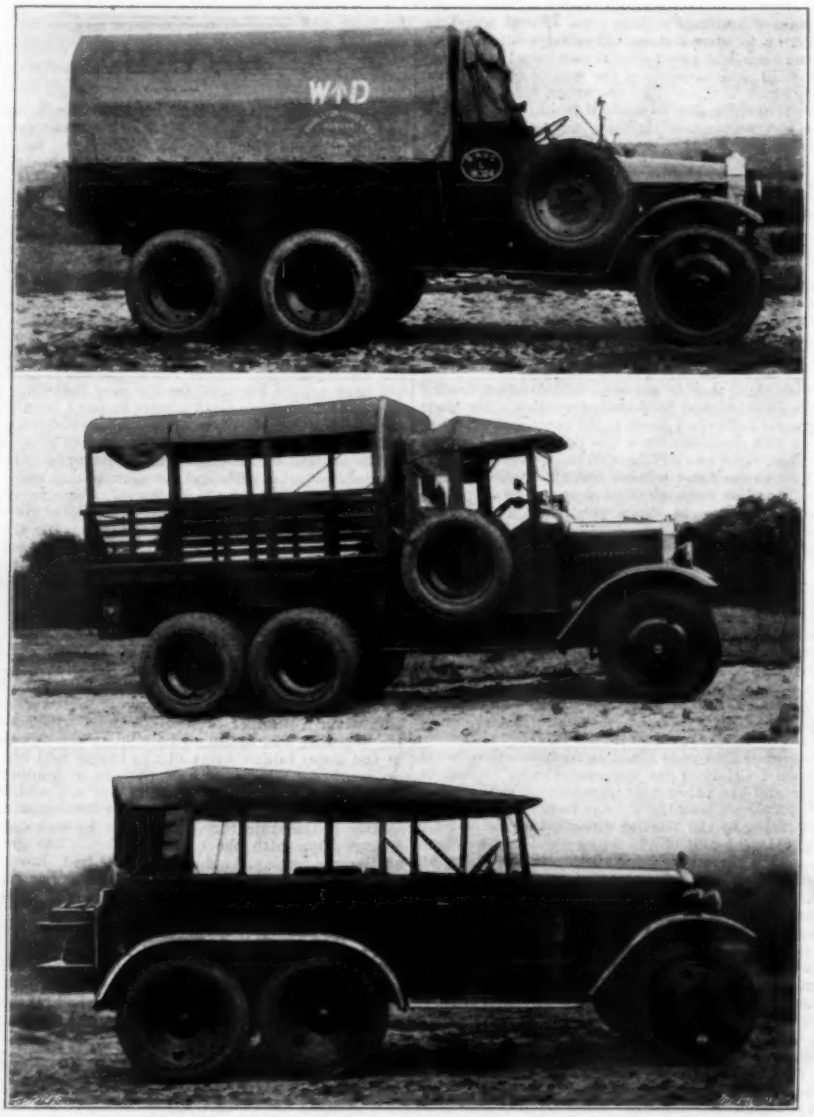


FIG. 11—W.D. Type "Medium" Rigid-Frame Six-wheeled Lorry (Thornycroft)
W.D. Type "Light" Rigid-Frame Six-wheeled Lorry (Morris)
Five-Six Seat Car (Morris)

The W.D. specifications have the following uses:—

(1) They indicate the nature of the peace time and war time requirements of the Department.

(2) They form a guide to the industry in regard to the characteristics of vehicles designed for high performance for use at home and for export.

(3) They form the measure of the suitability for acceptance of vehicles for enrolment under any subsidy scheme which may be in force.

The probable *rôles* of the various sizes of six-wheelers named may be summarised roughly as follows:—

Light.—(*a*) For first line transport in lieu of existing animal transport. Requirement:—Small load, highest performance. Mechanisation of first line transport is on trial on a small scale. Thus there may be a big future for the machine; (*b*) for various second line duties when a vehicle smaller than the "Medium" is required; (*c*) for ambulances.

Medium.—For second line transport for Divisional Supply, Baggage, Ammunition Services, &c. This vehicle may thus take the place of the 30-cwt. subsidy lorry. The present W.D. subsidy exists to provide vehicles for these services, and when the specification now in print is ready for issue an announcement that the Medium six-wheeler is eligible for the subsidy may be expected.

Heavy.—For rearward services and technical loads. Heaviest (bulk) loads and least cross-country performance necessary.

Car.—A light six-wheeled chassis carrying a five-six seat passenger body is in process of test. There is great need of a motor car with cross-country ability in the field organisation of the Army.

W.D. SIX-WHEELERS AND THEIR PERFORMANCE.

Factor of Performance.—Before describing actual examples of the W.D. six-wheeler and its performance, it must be explained that, owing to the difficulty experienced during the W.D. investigations in estimating and comparing the potential cross-country performance of these six-wheeled vehicles, it was found desirable to institute what is now termed the "Factor of Performance."

This figure, which represents cylinder volume swept per unit of advance of the vehicle in its lowest gear per ton of gross weight, has proved a very useful and reliable comparative measure, taking account of the main variants affecting extreme performance (see Appendix). M.E.P. and mechanical efficiency are not allowed for.

$$\text{Factor of performance} = \frac{A \times 2 \times S \times N \times R}{W \times T}$$

where A = area of a piston in square inches,
S = stroke in inches,
N = number of cylinders,
R = total gear reduction between engine and road wheels in lowest gear,
W = gross weight of fully loaded vehicle in tons,
T = effective circumference of tire in inches.

As an example, the "Medium" six-wheeled lorry specification calls for a factor of performance of not less than 55.

W.D. Six-wheelers.—Fig. 11 shows the general appearance of three types of vehicles which have been thoroughly tested and are in daily use by the W.D. They are in manufacturing production. The general characteristics of these machines are given in the Appendix.

Fig. 12 shows the general lay-out of the chassis of one of these vehicles.

* The Institution of Mechanical Engineers.

Fig. 13 gives a close-up view of the rear portion of the chassis with wheels removed to show the rear springing.

Cross-country Performance.—Fig. 14 shows vehicles travelling across country, and gives some idea of their extraordinary qualities of flexibility of suspension, tractive effort, and adhesion.

It is extremely difficult to define or compare cross-country ability. On one day on one kind of ground vehicle A may prove itself superior to vehicle B. On the following day the same ground is wetter, or drier, and B is found to do so. There is no doubt that the more positive grip obtainable in emergency by the use of such a device as the overall chain is the only factor which can level up the elusive and constantly varying relationships between adhesion between tire tread and ground, shear strength of ground, tractive effort available, intensity of pressure between tire and ground, and rolling resistance.

In the Appendix are given a few figures indicative of the cross-country performance of six-wheelers compared with previous types of four-wheelers used by the Army.

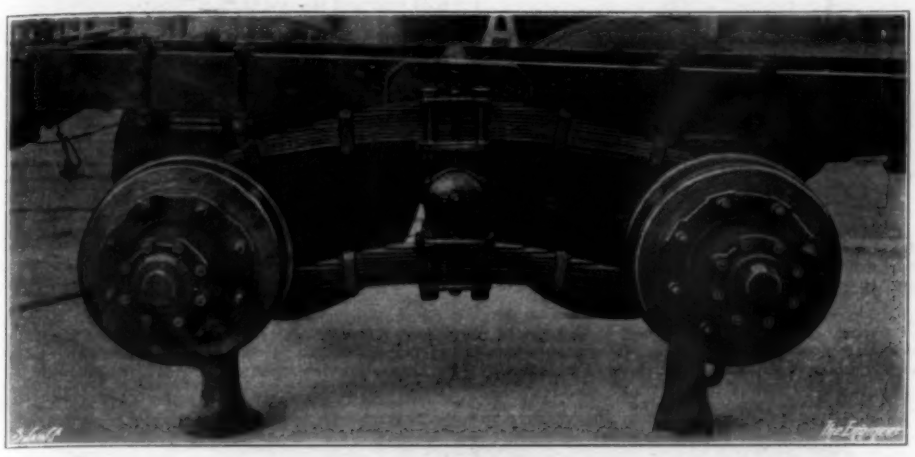


FIG. 13—Rear Springing (Guy)—Wheels Removed

superior to A. The following figures give some indication of the variation of ground condition :—

(*a*) Rolling resistance in blown soft sand 8in. deep, dry, 550 lb. per ton.

Rolling resistance on same sand, damp, 340 lb. per ton.

Rolling resistance on same sand, wet, 325 lb. per ton.

(*b*) On clay grass land the following figures have been measured :—

Condition of gr'nd.	Ground pressure (lb. per sq. in.).	Sinkage of driving wheels (inches).	Rolling resistance (lb./t'n)	Slope climbable (tan. of angle).
Dry ..	58	Not appreciable	105	1 in 2 without chains
Damp	20	1	316	1 in 3 without chains 1 in 2½ with chains
Wet ..	12	1¼	416	1 in 6 without chains 1 in 4 with chains

Although in order to cope with the majority of cross-country conditions, it is essential to have a very low

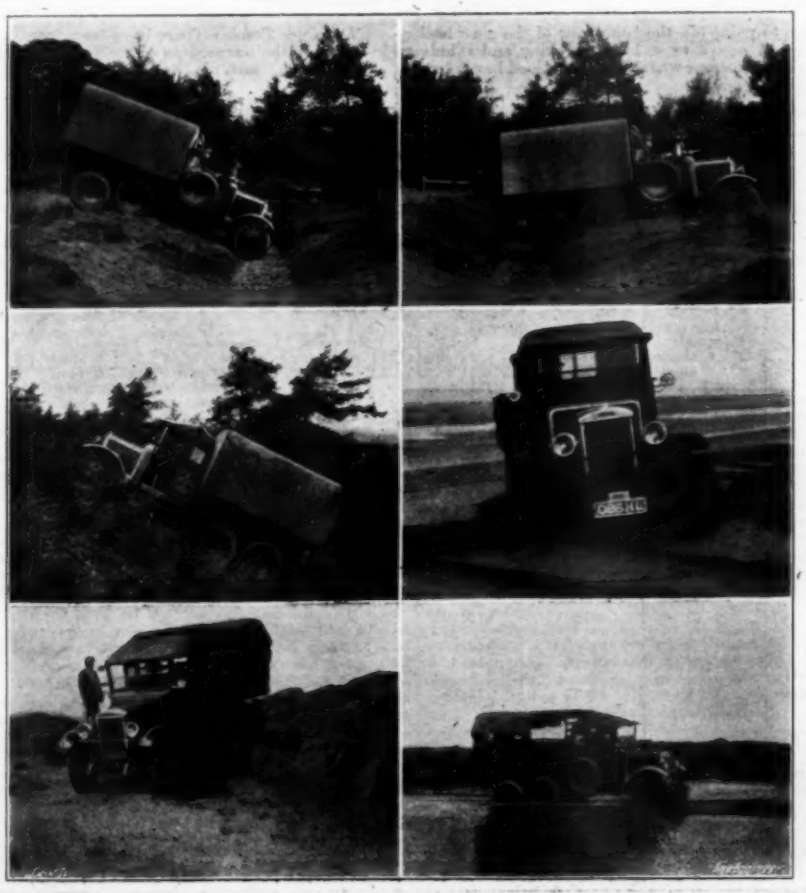


FIG. 14—Cross-Country Travel
Gradient 1 in 2½, Natural Bank
Over Boulders

Cross-Country Travel
On Soft Sand
Through Marsh

intensity of pressure between tire and ground, it is found, on occasions, that the addition of extra load will enable a vehicle to obtain adhesion where it would otherwise fail

The general structure of the vehicle naturally affects its ability to traverse rough ground, and Fig. 15 indicates the more important dimensions to be taken into account. The following are the actual dimensions in the case of a typical "medium" vehicle :—

A = 12½in.	D = 40 deg.
B = 11in.	O = 38 deg.
C = 66 deg.	R = 28ft.

The belly clearance of the vehicles is perhaps their weakest point, and in this respect a half-track machine can be made superior. The six-wheeler can be helped by mounting a spare wheel on each side of the vehicle on a primitive bearing in such a position as to protect vital parts of the "belly" of the machine (Fig. 16). This is not so simple as it looks—the mountings must be very strong and undesirable stresses guarded against. In actual practice the power of the vehicle to negotiate obstacles without this special safeguard meets all normal requirements.

It is not easy to get sufficient body space for commercial needs without having either excessive rear overhang, or too long wheel base (with poor belly clearance), or a faulty load distribution over the axles.

The difficulty of obtaining great body capacity is aggravated by the fact that provision has to be made, by means of wheel arches or otherwise, for two wheels under each side of the body, and clearance allowed for the wide range of movement permitted to these wheels. As will be seen from the various illustrations, the W.D. has adopted a "well" type body as standard, such bodies being simple and cheap to produce, and capable of being fitted readily to different makes of vehicle which may have slightly different wheel bases.

The W.D. is now, for the first time, ready to accept the forward control position for the driver, in order to reconcile a long body with a reasonably short wheel base. Forward control has many desirable features, *e.g.*, shorter and lighter chassis for a given body space, smaller turning circle, but accessibility of vital parts must not be sacrificed.

Road Performance.—Hitherto any new type of vehicle which has shown any marked advance over its predecessors in regard to cross-country ability has suffered from dis-

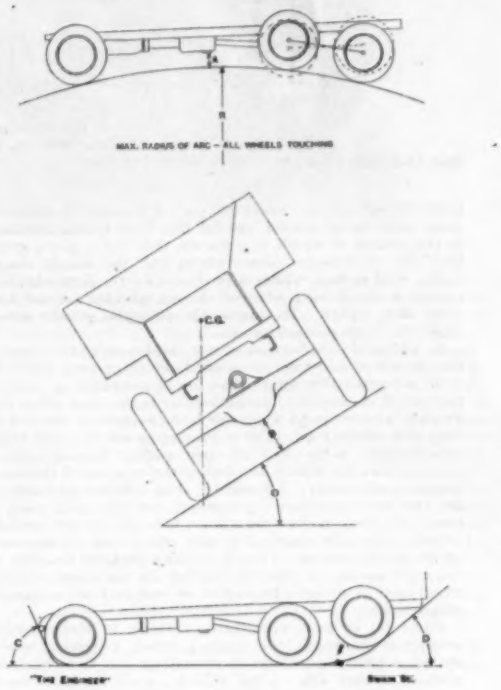


FIG. 15—Clearance—Side Stability—End Fouling

abilities in regard to its road performance. However attractive a vehicle with cross-country ability may be for use in distant parts of the Empire, its adoption in the commercial life of the home country must be mainly dependent on its efficiency as a transport vehicle on home roads.

As the result of full investigation the rigid-frame six-wheeler emerges as not only a very fine cross-country machine, but also as a most economical and efficient road vehicle—a unique combination of qualities.

The W.D. six-wheeler specification is purposely framed so that the vehicle can be designed to incorporate standard components employed in the production of normal four-wheeled vehicles in regard to all the major assemblies. The value of the special parts required to build up these standard assemblies into a six-wheeler is relatively small. Hence the initial cost of the vehicle is reasonable.

It is found, moreover, that this type of six-wheeler will carry a very much larger useful load than the equivalent four-wheeler based on the same major assemblies, and at a more economical cost per useful ton per mile. The main

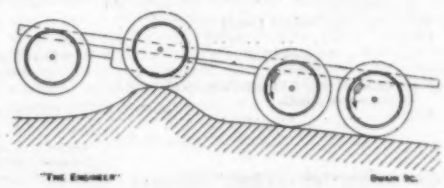


FIG. 16—Spare Wheels Protection

reasons for this economical road performance appear to be :—

(*a*) That owing to the light axle weights the rolling resistance in respect of road deformation is reduced.

(*b*) That owing to the action of the rear suspension, driving wheel slip is almost entirely eliminated.

(*c*) That owing to the independent action of the wheels, the movement imparted to the frame of the vehicle, at its point of maximum load, when a driving wheel passes over an obstacle, is only half or less of the height of the obstacle, irrespective of spring action (instead of the whole height in the case of the four-wheeler).

(*d*) That any transmission or driving wheel brake is, *ipso facto*, a four-wheel brake.

(*e*) That the distribution of the load over more wheels enables pneumatic tires of reasonable size to be used with safety. Furthermore, should a driving wheel tire burst the frame drop is only half the diameter of the tire section. Passenger-carrying vehicles can be tilted to an angle of 50 deg. without overturning.

(*f*) That, having a reserve set of gears at hand for extra steep gradients, the road set of gears can be comparatively high and the four gears not too widely separated.

It has been estimated by some observers that if the cost of moving a given useful tonnage by four-wheelers is represented by a figure of between 7 and 9, then the equivalent figure for doing the same work with six-wheelers is of the order of 5. Possibly this is an over-statement of the case,

and certainly it is too early as yet to go much further than an estimate based on practical experience up to date.

A few suggestions based on the points (*a*) to (*f*) are, however, offered for consideration. A number of valuable tests have been carried out by the U.S. Roads Bureau, in the course of which it is shown that for a given gross load the six-wheeler causes about half the tensile stress in the road surface which is produced by the four-wheeler, provided the driving axles of the six-wheeler are not less than 36in. apart. It is possible that the power saved under (*a*) is not inconsiderable.

In addition to reduction of wear and tear on the engine, transmission, and tires as a result of (*b*), power must be more economically used when its application is steady, instead of constantly fluctuating, as is the case when the driving wheels spend a considerable portion of their running time off the road. The bogie suspension, by permitting independent movement of any single driving wheel, ensures that the wheels can follow the contour of the road surface quite freely. Since there is no differential between the two driving axles, "spinning" can only take place if either the two driving wheels on one side of the vehicle or two diagonally opposed driving wheels, are off the road at the same instant. Thus it is clear that, in the case of the rigid-frame six-wheeler running on the road, driving wheel slip is either eliminated or reduced to negligible proportions.

Point (*c*) is most important. Owing to the pivoting action of the bogie, the impact, when a driving wheel strikes a road inequality, is shared by the tires of both wheels on that side of the vehicle, quite irrespective of spring deflection. Taking this fact into consideration, together with the low impact value of the pneumatic tires used, and the fact that the point at which the spring is pivoted on the frame moves only half or less of the amount of vertical displacement of the wheel (again irrespective of spring action), it seems obvious that a considerable saving in power must result.

Fig. 17 gives dynamometer readings of the pulls required to pull a four-wheeled solid-tire lorry and a six-wheeled pneumatic-tired lorry (both carrying 4 tons of useful load) at slow speed over an obstruction 1in. high on a hard road.

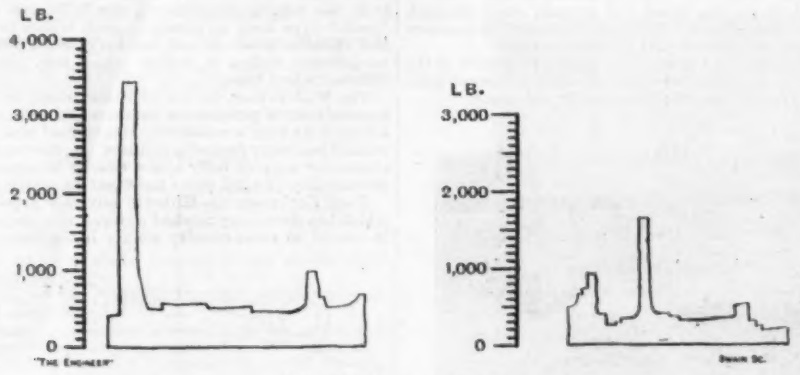


FIG. 17—Dynamometer Records
Rolling Resistance over 1in. Obstruction on Hard Macadam Road
Four-wheel Solid Tired Lorry. Gross Weight 7·83 Tons "Medium" Six-wheeled Pneumatic Tired Lorry. Gross Weighs, 8·45 Tons

Four-wheeler.—Maximum axle weight 5 tons 19 cwt.
Six-wheeler.—Maximum axle weight 3 tons 6 cwt.

At the same time the smoothness of travel gives, of itself, most important advantages in regard to comfort in the case of passenger vehicles, and results in a reduction in chassis and body wear and tear due to road vibration.

Referring to point (*d*), the behaviour of the six-wheeler on the road in regard to stability, braking and skidding is remarkable. The four wheels under the load have perfect road adhesion, owing to the form of suspension, and are all braked. Hence the vehicles can be driven at higher speed with increased safety, even on roads which would be most treacherous to a four-wheeler.

The very wide range of gears referred to in (*f*) makes it clear that, whilst a moderate load can be moved economically at high speed, the high tractive effort available (coupled with excellent adhesion) enables heavier loads to be moved at more moderate speed, when desired, by the use of trailers, &c.

It is hardly necessary to emphasise the great bearing which the features just examined have on reduction of road wear and the cost of road upkeep.

Unfortunately it has been impossible to collate any comprehensive figures in regard to road running costs as far as W.D. vehicles of the new type are concerned, since the time available has been used to subject them to continuous and strenuous cross-country work, as being the surest method of bringing to light any weaknesses. The Appendix includes a few figures of road performance ascertained on W.D. tests.

Nothing is more fallacious than an indiscriminate comparison of consumption figures. Variable factors of road and weather conditions, driving (coasting or no coasting), &c., must be known. On W.D. tests no coasting is permitted. Results of the running of a rigid-frame six-wheeler in independent hands are as follows :—

Useful load, 4 tons.
Average daily mileage, 85·76.
Total mileage, 8061.
Petrol consumption over all mileage, both loaded and empty (considerable town work), 9·76 miles per gallon.
Oil consumption on same basis, 268·7 miles per gallon.
Expenditure on repairs, &c., 0·31d. per mile.

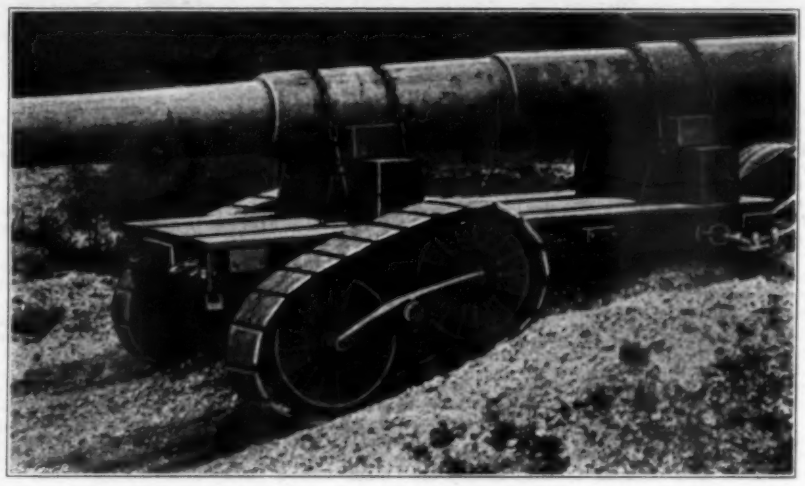


FIG. 18—Girder Track under Heavy Load

The Girder Track.—There have been many attempts to incorporate the advantages of the wheel and the track in one machine, such as the French tanks and artillery

APPENDIX.—*Comparative Structural and Performance Features of Various Types of War Department General Service Load-carrying Vehicles.*

		A.	B.	C.	D.	E.	F.	G.
1. W.D. type	—	Heavy van, four-wheel	Post-war subsidy lorry, four-wheel	Post-war heavy lorry, four-wheel	Light six-wheeled lorry	Medium six-wheeled lorry	Medium six-wheeled lorry	Medium six-wheeled lorry
2. Gross weight, including body, load, full W.D. equipment (including non-skids or overall chains) ready for road, tons	(See notes at foot)	2·85	3·7	6·85	3·5	6·95	7·45	6·75
3. W.D. useful loads (in commercial use some of the machines may be sold to carry greater loads)	On road (tons)	0·75	1·5	3	1·5	3	3	3
	Cross-country (tons)	—	—	—	1	2	2	2
4. Maximum axle weight (tons)	—	1·9	2·6	5	1·35	2·75	2·8	2·8
5. Tires	Type	Pneumatic	Pneumatic	Solid	Pneumatic	Pneumatic	Pneumatic	Pneumatic
	Wheels : Front	32″×6″ single	34″×7″ single	5″×28″ single	32″×4½″ single	36″×6″ single	36″×6″ single	36″×6″ single
	Driving	32″×6″ single	34″×7″ single	5″×34″ twin	32″×4½″ twin	36″×6″ twin	36″×6″ twin	36″×6″ twin
6. Maximum intensity of pressure on ground in lb. per square inch	—	60	65	151	58	49	55·5	45
7. Engine	Number of cylinders	4	4	4	4	4	4	4
	Bore	3·5″	3·75″	4·75″	3·125″	3·94″	4·25″	3·75″
	Stroke	4·8″	5″	6″	5″	5·5″	5·5″	5″
	Treasury rating	19·6	22·5	36·1	15·9	25·4	28·8	22·5
8. Gear ratios—engine to road wheels	For road use	1st 27·9 2nd 16·4 3rd 12·0 4th 6·75	1st 33·0 2nd 16·37 3rd 9·87 4th 6·25	1st 43·72 2nd 23·68 3rd 14·44 4th 8·25	1st 25·0 2nd 17·4 3rd 12·3 4th 7·25	1st 33·35 2nd 19·5 3rd 11·96 4th 7·5	1st 39·0 2nd 22·5 3rd 13·05 4th 7·5	1st 39·0 2nd 20·5 3rd 12·5 4th 7·5
	For cross country	Nil	Nil	Nil	1st 81·5 2nd 57·0 3rd 40·0 4th 23·5	1st 93·0 2nd 54·75 3rd 33·5 4th 20·25	1st 94·0 2nd 54·0 3rd 31·5 4th 18·1	1st 94·0 2nd 47·0 3rd 28·25 4th 17·75
9. Factor of performance	For six-wheelers	—	—	—	67·96	63·3	69·6	54·3
10. Maximum draw-bar pull on level macadam roads, lb.	—	1545	3100	5410	4300	6800	9130	6890
11. Maximum road speed, miles per hour	Over one mile	35	34	26	33·6	27·3	32·7	29
12. Average speed for 116 miles of good road surface, but fairly hilly, miles per hour	(See notes at foot)	22·82	21·12	16·6	23·2	21·3	24	22
13. Fuel consumption (no coasting) $= \frac{\text{useful tons} \times \text{miles}}{\text{gallons}}$	With W.D. road load carried (See 3 above) (See notes at foot)	9·94	19·97	21·78	22·5	23·6	24·6	24·9
14. Maximum gradient climbable	With two-thirds of road load carried (see 3 above) :—							
	(*a*) On gravel with loose surface	1 in 6	1 in 6	1 in 7	1 in 2·5	1 in 3	1 in 3	1 in 3
	(*b*) On dry heather and grass land	1 in 6	1 in 6	1 in 7	1 in 2	1 in 2·5	1 in 2·5	1 in 2·5
15. Approximate per cent. cross-country ability as between the best and the worst performance of the vehicles in question	—	50	50	0	100	80 to 90	80 to 90	80 to 90
16. Braking system	Hand	Normal	Normal	Normal	Normal	Normal	Normal	Normal
	Foot	Normal	Normal	Normal	Servo	Westinghouse	Normal	Normal

Item 2.—The vehicles are all carrying the full equipment necessary for active service. In addition, vehicles D, E, F and G are fitted with twin wheels and tires on each driving hub and carrying their "overall" non-skid chains. For road work single tires are quite sufficient and the "overall" chains unnecessary. Removal of four wheels and tires and the overall chains would reduce the weight figure for these machines by 6 cwt. for D and 10 cwt. each for E, F and G. This reduction would affect figures in Items 12 and 13 favourably.

Items 12 *and* 13.—No coasting or special adjustments.

Item 13.—The W.D. road load is not necessarily the full commercial load capacity.

e.g.:—*Vehicle F* handles 4 to 5 tons load with comfort on the road. The figures for Items 12 and 13 for this vehicle carrying 5 tons load are 20·8 miles per hour and 30 useful ton-miles per gallon.

Vehicle G, carrying a load of 66 cwt. and running on six instead of ten wheels (see [*a*] above) gives a consumption figure of 31·6 useful ton-miles per gallon.

tractors designed by Colonel Rimailho, certain British tanks and the Vickers car, all of which carry independent "wheel" and "track" equipments, changing over from one to the other by mechanical means. Less elaborate and cheaper—if more cumbersome—schemes, are those in which, on half-track vehicles, the track units can be removed and wheels substituted.

The six-wheeler itself and the overall chain already described represent a somewhat primitive but quite effective arrangement, having certain points of merit in regard to cheapness, light weight, speed of application and adaptability to ordinary commercial type six-wheelers. In this connection the fact should not be lost sight of that the six-wheeler has, as it stands, such very great ability to negotiate bad "going," compared with the vehicle of normal lay-out and drive, that the occasions when the use of any special non-skid device is called for are proportionately less.

A new form of track, known as the Girder Track, is at present being developed by Messrs. Roadless Traction. This track, in its application to the six-wheeler, represents a new departure which combines the best features of other schemes with merits peculiar to itself. The underlying principle is to secure the advantages of a wheel of very great diameter and width of tread (low ground pressure, sinkage, and rolling resistance), for negotiating obstacles and soft ground, without having the weight and inconvenience of the large wheel itself.

The track consists of an endless chain of metal units jointed together by pins or other suitable means, running around two wheels. The joints are designed so as to restrict the amount of hinging between adjacent track units in such a manner that, under the weight of the two wheels running on the inside of it that portion of the track between the wheels and the ground becomes automatically locked in the form of a short arc of a very large circle.

The wheels therefore are always running or driving on a smooth, hard, and rigid roadway, whatever the nature or inequalities of the ground, whilst the shape and area of the track resting on the ground are such as to reduce sinkage and rolling resistance. Fig. 18 shows a track embodying this principle applied to the axle of a trailer carrying a very heavy load. Fig. 19 shows diagrammatically the effect of applying such a track to the six-wheeled vehicle and also the relative actions, on soft ground, of the "overall" chain and the girder track.

The design of a track to run on the two twin-tired driving wheels on each side of a six-wheeled lorry is in progress,

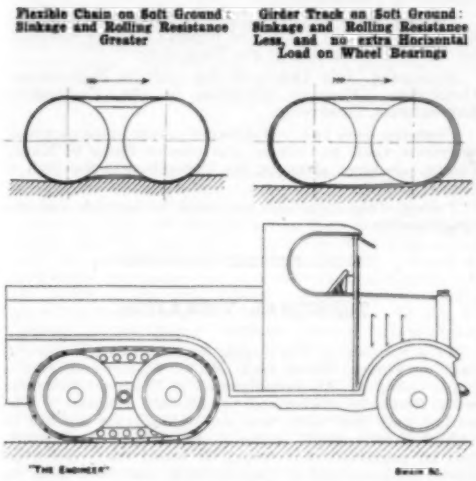

Flexible Chain on Soft Ground: Sinkage and Rolling Resistance Greater
Girder Track on Soft Ground: Sinkage and Rolling Resistance Less, and no extra Horizontal Load on Wheel Bearings

FIG. 19—Six-Wheel Lorry on Girder Tracks

and the results of practical test are awaited with interest. When the six-wheeler is employed in country where greater adhesion than the tires of the driving wheels themselves can give is required only for a small percentage of the total mileage, it would seem that a device such as the R.A.S.C. pattern "overall" chain forms the lightest and cheapest emergency equipment. There is a possibility, however, that the girder track may enable the six-wheeler to cope with the most extreme conditions on equal terms with, or even with advantage over, existing types of half-track machine.

Conclusion.—It may not be out of place to mention a few special points of technical development in which the War Department is interested.

(*a*) *Brakes.*—It seems certain that as the speed and weight of vehicles and the number of vehicles on the roads increase it must become more and more important that brakes themselves shall be more efficient, and that the driver shall be relieved of the labour of applying them by his own unaided strength. Operation by fluid pressure appears to have considerable advantages, especially in the case of vehicles such as the War Department type six-wheeler where great relative movement between brakes and chassis frame occurs. Fluid pressure systems also commend themselves for the control of the brakes of trailers. The effective cooling of brake drums is important.

(*b*) *Engine Cooling.*—Water cooling has many disadvantages from the soldier's point of view, viz., vulnerability to damage by enemy action, danger of damage by exposure and frost, weight, loss of water in hot and waterless countries, thermal inefficiency for widely varying climatic conditions, &c. The War Department is watching both air and steam cooling with interest, but, in the case of general transport vehicles, must perforce be content with whatever type of cooling system the commercial user prefers at present.

(*c*) *Gears.*—It is of great importance that gear changing on military vehicles, especially when they are liable to be used off the road, should be as simple and fool-proof as possible. It is hoped that some of the several new types of gear-box now in the experimental stage, in which the clash change is obviated, may be perfected and adopted commercially.

(*d*) *Alternative Fuels.*—Within the last few years great strides have been made on the Continent in regard to the successful application of the gas producer to the road vehicle. The principal fuels used are natural or compressed charcoal or chopped green wood. The War Department has carried out tests of some producer plants made in this country, with results which were only partially successful. It is hoped to try out a French plant at an early date.

(*e*) *A Six-wheel Drive Tractor Lorry* is in process of completion by the War Department at Aldershot. The general lay-out of the machine will be similar to the War Department type six-wheeled lorries already described, but the front steering wheels will drive also. The basis of this machine is a 54 horse-power (Treasury rating) four-wheel drive Thornycroft "Hathi" tractor—a type of tractor which is built to War Department specification. It is hoped that the tests of this vehicle will produce valuable data and that it will prove capable of a fairly high degree of performance with heavy loads.

(*f*) *Bodies.*—Experimental design and construction are in hand by the War Department of several types of bodies which, it is hoped, will be of adequate strength for active service, but which will be much lighter than existing types. Duralumin extruded sections for framing are being used to some extent.

In conclusion, the writer hopes that the general description which he has attempted to give of the first steps in the development of the true multi-wheel road vehicle in this country may be found of some interest, and desires to acknowledge most gratefully the assistance he has been given in the provision of illustrations and data by various individuals and firms.

A Steam Engine Designed for Export.

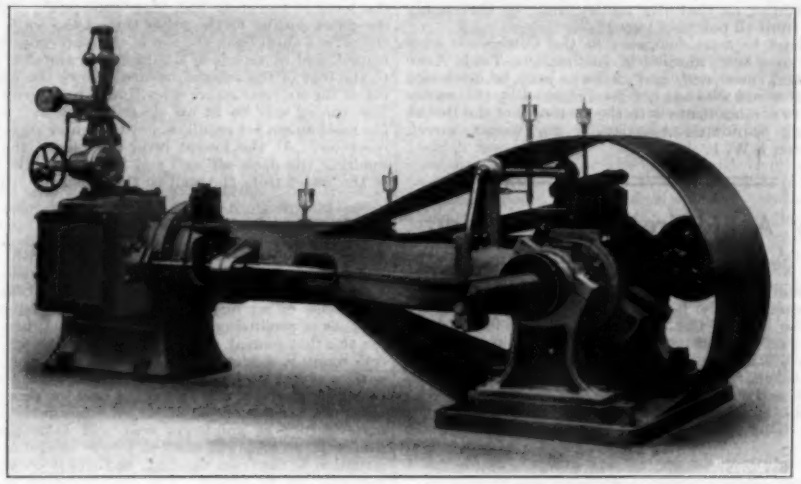
ON the occasion of a recent visit to the works of E. S. Hindley and Sons, at Bourton, Dorset, we inspected under test an improved type of horizontal steam engine, which the firm has recently put on the market. It was designed, we are informed, to meet the demand for an export engine, which would be intermediate in cost and performance between the ordinary steam engine and a high-class steam engine fitted with drop valve gear. The principal feature of the design, which the two accompanying engravings clearly show, is the use of a "Y" type of frame, which is split and flanged so as to divide the engine into two main parts—the cylinder and crosshead guide and the crank shaft unit. By using the "Y" frame considerably more rigidity is obtained than would be possible with an overhung crank, while the dividing of the frame into two main pieces facilitates packing, and at the same time simplifies the work of erection so that it may be carried out without employing highly skilled labour. In the second engraving it will be seen that the crank shaft bearings, which are of the ring oiled type, are fitted with easily removable white metalled bearing shells. The two bearing pedestals are bolted and pinned to a cast iron sole plate, which is furnished with an upturned rim, so that it forms an oil tray. On the inside of each pedestal casting there is a broad face, which is machined to take the flanged foot on the main engine frame, while vertical brackets with lugs are provided, through which the horizontal tie rod and distance piece passes. As we show in our first illustration, these lugs also support a planished steel oil splash guard, which, in turn, carries the sight-feed lubricators for the excentric, connecting-rod and crosshead pin bearings. A centrifugal oiler of the disc type conveys oil to the crank pin. The excentric rod pin, crosshead slippers and slide rod guide are furnished with wick type lubrication, whilst a mechanically operated sight-feed lubricator worked from an adjustable sleeve connection on the valve rod provides oil for cylinder lubrication.

The crank shaft may be either of the plain bent type or for high speeds a slab type of crank, with cast iron balance weights as illustrated in the first engraving may be employed. In the engine we inspected the crank shaft was extended to carry a fly-wheel, and a self-oiling outboard bearing was provided.

Brief reference may be made to the valve gear, which is of the "D" slide valve type, with a circular faced balance ring. The excentric adjustment is so designed that the expansion can be varied to suit the load under which the engine is designed to work. The stop valve governor of the Pickering type is belt-driven from a pulley on the crank shaft, and an automatic shut-off gear is provided.

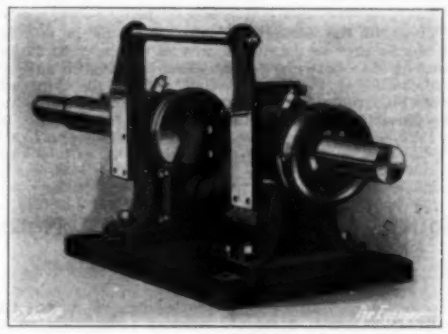
75 B.H.P. STEAM ENGINE FOR EXPORT

E. S. HINDLEY AND SONS, BOURTON, DORSET, ENGINEERS



The engine, which we saw under test, had a cylinder diameter of 12in., with a stroke of 18in., and was designed for a normal continuous output of 75 B.H.P. at a speed of 145 r.p.m. In the three-hour continuous and the overload tests, which were run on January 25th and 26th respectively, the engine was shown to be capable of developing its normal rated power and an overload of 83·2 B.H.P. at the same engine speed, with a stop valve pressure of 100 lb. At the close of the three-hour test we found the bearings to be quite cool. In order to demonstrate the steadiness of the engine under load, the four holding-down bolts of the cylinder base were eased off, but no movement whatsoever took place. Referring to the ease of erection, the makers claim that when the crank shaft unit has been lined up and levelled, it is only necessary to bolt on the cylinder and guide frame, meanwhile supporting the cylinder base on a single roller, while the flanged joint in the main frame is bolted up and positioned by the set pins. The cylinder base thus takes up its normal position and can be wedged up and grouted in in the ordinary manner.

As regards steam consumption, the makers state that under ordinary commercial conditions a figure of from



CRANK SHAFT UNIT

25 lb. to 32 lb. per B.H.P. per hour can be obtained with single-cylinder engines working with steam at 100 lb. gauge pressure. Engines of the pattern we have described are, we are informed, built in nine sizes, varying from 30 to 300 B.H.P., and are designed for steam pressures up to 120 lb. per square inch. With a tandem arrangement of cylinders boiler pressures up to 150 lb. can be conveniently arranged for.

WIDTH ACROSS FLATS OF NUTS AND BOLT HEADS.

AN important conference of makers of bolts and nuts, as well as the engineers who use them, is being convened by the Screw Threads Committee of the British Engineering Standards Association, and will take place in London on Wednesday, March 30th. The object is to discuss the question of the width and thickness of nuts and bolt heads from the view point of the practicability of a reduction on the standard sizes ordinarily used.

It will be remembered that the present dimensions for British Standard Whitworth (B.S.W.) and British Standard Fine (B.S.F.) bolts were adopted by the B.E.S.A. in 1908 and 1911 respectively, the latter at that time being known as the British Automobile Standard. The dimensions adopted for B.S.W. bolts were practically those specified originally by Sir Joseph Whitworth, while those of B.S.F. bolts were derived from the original Whitworth Standards by utilising as the nut for a given bolt, the standard nut for a bolt one size smaller in the Whitworth series.

Various reasons in recent years have, for certain purposes, led to the use on B.S.W. bolts of nuts smaller than the standard size; in particular it has been usual to employ in automobile work B.S.F. size nuts on B.S.W. bolts.

The continental countries which have adopted the Whitworth screw thread as one of their standards have been using nuts which are smaller than the B.S.W., and as the question of arriving at a uniform standard is engaging their attention as well as that of the United States of

America, and the B.E.S.A. as the national standardising body in Great Britain, has been invited to participate, the Screw Threads Committee has felt it highly desirable that it should make itself acquainted with the wishes of both makers and users concerned; hence the calling of this Conference so that the matter may be thoroughly discussed from all points of view.

Invitations to send delegates to the Conference have been sent to a large number of Institutions, Trade Associations, &c., concerned, and any who may be interested in the matter and who has not been reached by this means is invited to communicate with the Secretary of the British Engineering Standards Association, 28, Victoria-street, Westminster, S.W. 1.

New Anglo-French Submarine Telephone Cable.

THE facilities for Transcontinental telephone traffic were increased by the laying on the 16th inst. of a new cable in the English Channel. The cable is of the paper-insulated lead-covered type, and is described as possessing low electrostatic capacity and low leakance which, as is known, are characteristics very favourable for efficient speech transmission.

The cable is 23¼ nautical miles in length, is about 2·6in. in overall diameter, and weighs 623 tons. A section of it

is given in the accompanying engraving. It was laid in one length—so that there was no necessity to make a joint at sea—between Sandgate on the English side and Audresselles on the French coast. This is the third cable of its kind to be laid by Siemens Brothers and Co., Ltd., the previous examples being the Anglo-Dutch cable laid in 1924, and the Anglo-Belgian cable laid last year.

South African Engineering Notes.

Bulawayo Water Supply.

AN engineering undertaking of more than ordinary interest is rapidly nearing completion on the Khami River, about 14 miles from Bulawayo. By it 1240 million gallons of water are to be impounded to provide an additional water supply for the town. A concrete dam has been constructed across the Khami at a point where two kopjes form the banks of the river. One of the kopjes ends abruptly further up the river, and the damming of the river will lead to the water being turned into the valley on the other side of the kopje. On this other side another wall, with a concrete core, and faced with stone pitching, has been built across the valley to a third kopje. The concrete dam is 290ft. long on the crest, 45ft. wide in the middle, and 58ft. high from river bed.

The present volume of water held up by the dam is 830,000,000 gallons. By an arrangement of falling shutters on the top of the wall it is proposed to increase its capacity to 1,240,000,000 gallons. From the top of the sluice gates superstructure to the river bed is a height of 110ft. On the top of the superstructure are placed the winding gear and the controls for the gates, which can be easily operated by one man. The gates are so arranged that they may be operated automatically.

A noteworthy contrivance in connection with the gates is the arrangement to relieve the pressure on the dam in the event of a very high flood. At the tops of the two outer piers there are two penstocks leading to buckets which are suspended in wells by ropes attached to the controls of each gate at the top of the superstructure. The buckets have perforated bottoms. When the water held up by the dam rises to the height of the penstocks it will enter channels and fall into the buckets. Provided the inrush of water is not too great, the water will run out of the buckets as fast as it enters and will be carried off in pipes. But if the water in the dam rises so high that the inrush into the penstock is heavy enough to fill the buckets, then the bucket will slide down in their wells and the ropes by which they are attached to controls will release the retaining levers and automatically the gates will be raised and allow the water to rush through the openings in the dam. The penstocks can be adjusted so that the gates will lift when the water is, say, 2ft. or 3ft. or 5ft. above the crest of the dam. As soon as the gates begin to lift an alarm bell will sound in a caretaker's house, where there is a water level gauge erected for his guidance. The attendant or caretaker will close the gates after the subsidence of the flood waters and to perform that operation he has to get to the top of the superstructure.

A tunnel large enough to allow a man to walk upright has been built in the dam and runs throughout its length. The wall has been built over the top of the kopje and entrance to the tunnel is in the flank of the wall. By a series of steps the tunnel descends in the wall almost to the level of the river bed, then runs under the piers and the gates and up to the other side of the wall. At one of the piers a shaft from the top of the wall connects with the tunnel, and by means of a ladder the caretaker can ascend to the foot of the superstructure, thence the ascent to the top of the superstructure is continued by a series of ladders. The tunnel will be lit by electric light and will contain the mechanism for regulation of the water supply from the reservoir. At the lowest level are placed the levers for scouring the draw-off well and for controlling the supply of the water from the well to the purification plant.

Mining at Broken Hill.

Mining activity at Broken Hill (Northern Rhodesia) is taking place on an extensive scale nowadays. The Rhodesian Broken Hill Development Company is in the midst of an important construction scheme for the purpose of producing zinc, lead and vanadium. The plant for the first-named product takes up a large area. The cell room is a huge building, constructed of iron joists with a corrugated roof; next to it are the leaching and purification plant, the lead roller mill for producing sheet lead, the furnace department, the laboratory, &c. The manufacture of sulphuric acid will take place on the property, as also will that of ferro-vanadium. The construction is far from finished, as further consignments of material are to arrive. The concentrating and flotation plants have been running for some considerable time, both producing lead. One smelter out of three has been running all along, and probably all three are now busy. It is said that a good lode of sulphide of lead has been struck on the property, and that electrical prospectors have been, and are still, considerably used in the vicinity of the company's property, as they have been of great assistance in the discovery of sulphides.

A Funicular Railway.

In addition to the proposed aerial cableway up the front of Table Mountain, Capetown, negotiations in connection with which were recently concluded and operations started, a proposal has lately been approved by the City Council for the construction of a funicular railway up Muizenberg Mountain, situated 15 miles from Capetown and overlooking False Bay. This railway will start not far from the main road and will follow a comparatively easy slope on the southern side of the deep ravine which separates the two prominent portions of the mountain, terminating on a plateau at a height of about 1000ft. above sea level, where it is proposed to erect a restaurant. The intention is to use gravitational force as the source of motive power by filling tanks in the bases of the passenger cars at the upper terminus with water and discharging it from them on reaching the lower station.

Road Motor Services.

The Railway Administration has authorised a further ten routes to be served by its road motor services. All these new services will be in operation by the end of next June. The Administration started a road motor service between Muden and Greytown Station, a distance of 17½ miles, for the transport of citrus fruit during the season September–October last. The cultivation of citrus fruit has rapidly increased in that area of recent years. The fact that there is a rise of 2000ft. in 11 miles in the Greytown direction, while the ruling gradient is 1 in 10, called for careful consideration as to the best type of vehicle to be provided to handle the traffic. In the first instance it was decided to utilise on this service six-wheel 2½-ton vehicles, fitted with four-wheel drive and eight forward and two reverse gears, but owing to these special type vehicles not being available immediately, the fruit, for a considerable period, was conveyed by ordinary four-wheeled standard type lorries. Owing to the late arrival of the special type a definite conclusion as to its working was not possible. The performance of the vehicles, however, served to indicate that they may assist in solving the problem of providing transport over indifferent roads with severe gradients.

Developing Table Bay.

As a result of representations made to the Government with regard to the insufficiency of shipping facilities at Table Bay (Capetown), a committee was appointed in 1921 to inquire into and report upon the facilities existing, and to recommend improvements for their development. After considering several proposals the committee recommended for adoption what is known as the Modified Southern Scheme, which comprises the extension of the breakwater by 1500ft., widening of the South Arm of the present dock to 700ft., extending the return wall, a random block mole, four additional berths, cranes, sheds, dredging, reclamation, &c., and a new fishing harbour. The first item, the breakwater extension, was authorised in 1923 at an estimated cost of £651,264. The widening of the South Arm with certain works thereon, which is estimated to cost £1,182,468, was authorised in 1924, and during the latter part of 1926 approval was given to an expenditure of £2,502,373 for the remainder of the works comprising the Modified Southern Scheme. The undertaking, which will involve an estimated expenditure of over £4,300,000 and which will take several years to complete, allows for future expansion to meet the anticipated requirements of Table Bay Harbour for many years to come. All the works mentioned are being proceeded with. In the course of widening the South Arm a total of 1818 lineal feet of quay wall has been constructed to the required level upon which mass concrete has been laid to a distance of 1472ft. Four 4-ton electric cranes are in course of erection. The length of block work completed in the extension of the breakwater is 137 lineal feet, 126 concrete blocks have been placed in position, and 978 blocks have been made. The concrete retaining wall in connection with the widening of roadway on the ocean side of the East Pier has been completed and the other work necessary is well in hand.

Institution of Naval Architects.

THE following programme has been drawn up for the meetings of the Institution of Naval Architects on April 6th–8th in the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, W.C. 2:—

Wednesday, April 6th.—Morning meeting at eleven o'clock. Annual report of Council; election of President, Vice-presidents, officers and Council; presentation of Diploma of Honorary Membership to Admiral Sir Reginald Custance, G.C.B., K.C.M.G., C.V.O., D.C.L.; presentation of the Institution Gold Medal to Mr. Robert Sulzer, member; address by the President (His Grace the Duke of Northumberland, K.G., C.B.E., M.V.O.) The Hon. Sir Charles A. Parsons, K.C.B., D.Sc., F.R.S., Vice-president, "Some Investigations into the Cause of Erosion of the Tubes of Surface Condensers."

Thursday, April 7th.—Morning meeting at eleven o'clock. Professor W. E. Dalby, M.A., B.Sc., F.R.S., associate member of Council, "A Characteristic Energy Diagram for an Oil Engine and Marine Oil Engine Trials." Afternoon meeting at three o'clock. Mr. J. Douglas Calder, associate member, "Notes on the Design of Coasters"; Captain C. Blom, member, "The Future of Sailing Vessels Fitted with Auxiliary Motors." Evening meeting at eight o'clock, Mr. David Nicolson, member, "Design and Construction of High-speed Motor Boats."

Friday, April 8th.—Morning meeting at eleven o'clock. Election of new members, associate members, associates and students; appointment of scrutineers for the next annual meeting. Mr. J. L. Kent, member, "Propulsion of Ships Under Different Weather Conditions"; Mr. H. J. R. Biles, B.Sc., associate member, "Notes on the Effect of Wind on Power and Speed." Afternoon meeting at three o'clock. Mr. E. V. Telfer, M.Sc., Ph.D., associate member, "Ship Resistance Similarity"; Mr. W. C. S. Wigley, M.A., associate, "Ship Wave Resistance: A Comparison of Mathematical Theory with Experimental Results—Part II."

SUMMER MEETING IN CAMBRIDGE.

It has been decided to hold a summer meeting of the Institution in Cambridge and the neighbourhood on July 12th to 15th. The following is an outline of the programme (subject to modification).

Tuesday, July 12th.—Opening of the meetings in the Senate House, and reading of papers: evening reception by the Vice-Chancellor of the University.

Wednesday, July 13th.—All day visit to Bedford and Cardington. Evening reception in the Engineering Laboratories, Cambridge.

Thursday, July 14th.—Reading of papers in the morning, afternoon visits to Colleges and Garden Party in King's College; banquet given by the Institution in the Hall of Trinity College.

Friday, July 15th.—All day visit to Ipswich and the neighbourhood.

TORSIONAL VIBRATION.

AT a meeting of the Junior Institution of Engineers, held on Friday, March 18th, Mr. J. Calderwood, read a paper entitled "An Investigation of Torsional Vibration with Particular Reference to Aircraft Engines." The author said that there was available a vast amount of published information on the general subject of vibration, but on examination it would be found that very little work, mathematical or experimental, had been done on the particular problems which had to be considered by the designer of a machine liable to suffer from critical periodic torsional vibration of its shafting. In many cases in which trouble due to torsional vibration had been experienced, damping devices had been used. While a machine might, with heavy damping, run at a critical speed without fracture of the shaft, it was not under those conditions running economically, for a large amount of power was absorbed in damping the vibration. The alternative was to arrange the shafting of an engine in such a manner that the critical speeds were all either above or below any speed at which the machine might be required to operate continuously in service. In an appendix to his paper, Mr. Calderwood gave some formulæ for the calculation of the natural frequency of vibration of various arrangements of shafting such as occurred in aeroplane and airship engines. The paper concluded with a brief note on the measurement of torsional vibrations.

ELECTRICAL PROTECTIVE RELAYS.

A BRITISH Standard Specification just issued forms one of a series of specifications for electrical instruments which have recently been, or are about to be, published by the British Engineering Standards Association. The relays dealt with are classified:—(*i.*) According to the functions they perform, *e.g.*, over- or under-current, voltage and power relays and directional relays; and (*ii.*) according to the constructional principles involved, *e.g.*, solenoid relays, armature relays, permanent magnet moving-coil relays, &c. Relay contacts are also classified according to their function and mode of operation. The specification proper deals with the limits of current, voltage, and time-settings; the rating of the contacts; the volt-ampère consumption of the relays; limits of error; insulation and voltage tests, &c. The specification should prove of great interest to power-station engineers and other users of protective relays, as, although it is concise, it deals with the classification and performance of relays in a very comprehensive manner.

Copies of this new B.S. Specification (No. 142, 1927) may be obtained from the B.E.S.A., Publications Department, 28, Victoria-street, London, S.W. 1, price 2s. 2d. post free.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Market Position.

BUSINESS on the Midland iron and steel market is stagnant. High production costs are effectively preventing any expansion of trade. Consumers continue to press for deliveries under old contracts, but they refrain from placing new business at existing prices. The coke position is no easier, the ovens demanding 22s. per ton for their output, and furnacemen, forced to pay it, cannot give the price concessions demanded by consumers of iron. Steel values also rule high, and though many works still have well-filled order books, others are beginning seriously to canvass new business. The general position is most unsatisfactory, and unfortunately little sign of improvement is at the moment discernible.

Raw Iron.

The price concessions which have been made in Midland foundry pig iron have not produced any appreciable expansion of business. Foundrymen are still holding off, indifferent apparently to the expiry of contracts for continental supplies. It is recognised that there is a potential demand for more pig iron, but it depends upon a substantial lowering of the price. If it can be maintained, the attitude of the coke ovens must preclude the possibility of any such reduction in the price of pig iron as consumers demand. At the furnaces arrears of orders which had accumulated are being rapidly worked off. Thus far, few fresh contracts have been given out to take the place of the old, and some of the blast-furnaces are not now making full production. Derbyshire foundry iron is now quoted £4 2s. 6d. and Northamptonshire £4 per ton. There is little sign of movement as regards forge irons. Basic is quoted at £4, but this is not a price at which foreign competition can be held at bay. Following the drop in Derbyshire and Northamptonshire foundry irons, Cleveland furnacemen are now accepting £4, both for home and export business. Hitherto, an extra 6d. has been charged on iron for shipment, but the trade is anxious to get back the export markets, and now that the call for iron from the steel works is not so insistent, there will be more available for shipment. The Midland furnaces at work have great difficulty in carrying on owing to the irregular supplies of coke and high prices which ovenmen are demanding.

Steel.

Steel works are offering earlier delivery week by week. The accumulations of orders are being worked off, and makers are becoming anxious for new business. The incoming orders are disappointing, and the heavy output which has been maintained since the New Year opened will not continue unless bookings improve. Prices are nominally unchanged, but it is believed that a good order for plates of the ship, bridge and tank variety would probably be taken at 2s. 6d. less than the £8 17s. 6d. quoted. While there is continuous pressure for deliveries of structural steel, present employment depends very much upon old contracts. There is wide disparity between the prices required for quick delivery, and those which millowners are glad to accept for good contracts spread over the next quarter. They are prepared to sell sections forward at £7 17s. 6d. It is understood that at a recent meeting of the Steel Association, an advance of half-a-crown in the basis for sections was advocated, but not being unanimous, no action was taken. Market transactions have not pivoted on the official basis for a long time past. Prices actually paid are so much above the minimum that an advance such as was proposed would have no significance. Structural engineers receive a steady inquiry for small consignments of steel, but big business is being held back. The difficulty of obtaining British steel and the difference in the price as compared with continental material are no doubt responsible for the heavy imports of steel blooms and billets, &c., totalling 114,661 tons last month, as compared with 111,894 tons in January. The buying of continental material is not particularly active at the present time, but big quantities are being delivered and have yet to come in under agreements made some time ago. Prices have steadied following the recent slight advances, billets being £5 15s. Native steel works still quote mild steel billets £7 upwards.

Wrought Iron.

The Staffordshire trade in wrought iron remains sluggish. Business in marked bars is moderately active, but hardly any transactions are heard of in the lower grades of wrought iron. The shipbuilding improvement has resulted in some widening of demand for iron used in the making of anchors, cables and chains. Marked bars are maintained at £14 10s. Crown bars can be bought round about £11 10s., but the trade drags heavily. Producers of common iron have no chance to get on terms with the foreign competition which has long dominated this branch. Mills cannot turn out nut and bolt and hurdle bars at less than about £10 10s., but Belgian No. 3 bars can be bought at £6 5s. delivered.

Galvanised Sheets.

The trade in galvanised sheets which has been extremely quiet for some weeks past, now shows a slight improvement, both on home and export account. Inquiries are more numerous, and it is hoped this month to improve on February's returns of exports which showed a marked downward tendency. The tonnage exported in February was only 48,925, compared with 65,205 the previous month. It is remarkable that whereas when exports of iron and steel generally were falling those of sheets were maintained, now that exports of the former are advancing those of the latter are declining. The increase in freights on shipments to South Africa resulted in a decline of exports to that market, and this to some extent accounted for the general decline. Values of 24 gauge corrugateds range from £15 to £15 2s. 6d. per ton.

Imports and Exports.

The considerable increase in activity in the heavy industries of the country is shown by the statistics of imports and exports of iron and steel during February. It is evident that more native material is now being used, imports in many departments having declined considerably. In the raw iron department it is noticeable that only 1566 tons of forge pig were imported against 5369 tons in the previous month and 26,258 tons of foundry pig as against 48,094 tons. Imports of basic dropped from 37,068 tons to 21,887 tons. On the other hand, there was some increase in the exports of British pig iron, shipments of forge and foundry sorts amounting to nearly 5000 tons. They were, however, less than one-fifth of the total of a year ago. While the total imports of iron and steel amounted in February to 443,424 tons, roughly double the tonnage for the previous February, they were less by 112,000 tons than in January. Meanwhile, the exports reached 251,715 tons, compared with 219,369 tons in January and 158,664 tons in December. In most of the main categories there was some increase.

New Refuse Plant for Birmingham.

The Salvage and Stables Committee of the Birmingham Corporation has decided, subject to the Finance Committee being able to raise the money, to lay down special plant in Birmingham for the treatment of vegetable refuse on scientific lines, at an approximate cost of £5000. It is hoped to convert the refuse into a concentrated fertiliser in the form of powder. The new plant will be laid down at the Montague-street depôt, but it will be some time before it can be brought into operation. A large plant—the biggest municipal plant of its kind in the country—is already engaged on the conversion of the city's animal and fish waste into feeding meals and fertilisers, and it is believed the scheme now to be adopted will enable vegetable refuse to be dealt with on an economic basis, and produce a profit instead of a loss for the department.

Gas and Industrial Heating.

Some interesting particulars regarding the part played by gas in Midland industry were given at the Midland District Conference of the British Commercial Gas Association on the 16th. Dr. C. M. Walter, engineer-in-charge, Industrial Research Laboratory, Gas Department, Birmingham, in the course of a paper on industrial heating by town's gas, said that whilst in 1911 the total gas sold for such purpose in Birmingham amounted to only 389,511,000 cubic feet, representing 5·06 per cent. of the total gas sold, for the year ended March 31st, 1926, the total was no less than 2,643,998,000 cubic feet, or 19·74 per cent. of the total sold for all purposes. This industrial load had been largely due to the establishment in 1911 of a special section to deal with the application of gas to industry in Birmingham. In practically every modern hardening shop the gas furnace was being used to-day for such work as the carburising and re-heating of steel components. It had completely replaced the older type of solid fuel furnace. It might not be generally known that town's gas had been used with every satisfaction for the heating of lehrs for the process of annealing heavy cut-glass ware, and the results of a large number of experiments carried out on furnace plant of this kind showed that in every instance the reduction in breakage was very considerable indeed. In Birmingham alone upwards of 1000 industries were dependent on the city's gas supply for carrying out the multifarious heating operations in factories and workshops. The advantage of a supply of fuel by pipe to manufacturing premises, where floor space was limited, could not be over-estimated, and during the recent coal stoppage Birmingham manufacturers and others enjoyed a full supply of gas for the entire period.

Mining Developments.

It is reported that important mining developments in the Midland coalfields may be expected within the next few years. Several new collieries are likely to be sunk in the Nuneaton and Coleshill district, and these will most probably be run by electricity, on the same lines as the new colliery at Hurley, Warwickshire, which was recently opened. A West Bromwich firm interested in the coal trade has recently been negotiating for the mining rights of land in the Arley and the Fillongley areas, where it is known that rich seams of coal exist which have not yet been touched. This would mean that a new industrial centre would spring up on the Birmingham side of Nuneaton. The nearest colliery to this new mining site is Arley Colliery, which has made rapid development in recent years.

Birmingham Quarterly Meeting.

The second quarterly meeting of the Midland iron trade which in the ordinary course would fall on the eve of Good Friday, is being advanced to April 7th.

Unemployment in the Midlands.

After showing a consistent improvement in recent weeks, the Ministry of Labour's return recording the number unemployed in the Midlands, gives, for the current period, an increase of 2844, due in the main to short-time work in the mining areas. The total now stands at 136,280, to which the Birmingham area contributes 29,895; Bilston, 2483; Coventry, 2063; Cradley Heath, 2503; Dudley, 2734; Leicester, 4364; Northampton, 1781; Nottingham, 6709; Oldbury, 1212; Redditch, 886; Smethwick, 3346; Stoke-on-Trent area, 10,055; Stourbridge and Brierley Hill, 2484; Tipton, 1644; Walsall, 4841, Wednesbury, 2235; West Bromwich, 2486; Wolverhampton, 4765; and Worcester, 1352.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Engineering Works to Close.

RUMOURS were current several weeks ago of the prospective closing of the Globe Ironworks, Bolton, of John Musgrave and Sons, Ltd., but there was no authoritative information regarding the matter. During the past few days, however, an official statement has been published which says that the company has gone into voluntary liquidation, and that the works will be closed. There will be general regret in Lancashire that this step has become necessary, for the firm was one of the oldest-established and best known in the North of England. Messrs. Musgrave specialised in engine and boiler work, and were also engaged in general engineering work. It is interesting to recall that one of the biggest engineering jobs of the period—the construction for the Russian Government of a suspension bridge over the river Dnieper—was carried out by the firm just over seventy-five years ago. Of the normal complement of 1200 men at the works, only about 250 are now engaged, and it is stated that the orders on the books will be completed before the works are closed. The firm has been in existence for eighty-eight years.

Electrical Contract for Belgium.

An explanation for the placing of a contract for electrical equipment with a Belgian firm by the Electricity Committee of the Manchester Corporation is to be asked for at the forthcoming meeting of the City Council. The contract, which was to the value of approximately £4000, includes the supply of a generator. A number of British firms furnished tenders, but the most favourable of these is said to have been about £1000 higher than that of the successful Belgian tenderer.

Engineers' Difficult Time.

The influence of last year's coal stoppage on the operations of engineering firms in this area is further shown in the reports issued by Galloways, Ltd., of Knott Mill Ironworks, Manchester, and by Browett, Lindley and Co., Ltd., of Patricroft. The directors of the former state that the business shared in the general depression, which was accentuated by the engineering and coal disputes, the cessation of the manufacture of boiler-plates during the protracted period of the coal stoppage having a particularly adverse effect on the boiler works. The works came almost to a standstill, and the supply of plates, the directors say, is only now beginning to be satisfactory. Extreme caution on the part of buyers is still apparent, and it is pointed out that it is not possible to make a reasonably safe prophecy regarding a revival of trade. No dividend on either the ordinary or the preference shares is proposed for the past year, and a debit balance of £30,808, arrived at after charging debenture interest and allocating to the capital reserve the proportion of loss up to the date of the receiver's discharge, is carried forward. The directors of Browett, Lindley and Co. state that, owing to the general trade depression and the coal stoppage, last year was the worst ever known. They are hopeful, however, regarding the future outlook, as substantial contracts have been booked this year at better prices. A loss of £15,878 is shown on the year's working, after providing for interest, depreciation and contingencies, making, with the deficiency of £13,311 brought forward, a debit balance of £29,189 carried to the next accounts.

Cable and Electrical Profits.

A profit of £607,853, making with the balance brought forward a total of £832,771, is shown in the financial statement of British Insulated Cables, Ltd., whose annual meeting was held at Liverpool on Monday. A further dividend of 10 per cent. is being paid on the ordinary share capital, or a total distribution of 15 per cent. for the year, £271,721 being carried forward after providing for preference dividend, interest and depreciation, and allocating £200,000 to the reserve account. Here, again, the coal dispute had its effect, the company's works being closed down for nearly two weeks, and the profits being £62,447 less than in the previous year. The Metropolitan-Vickers Electrical Company, Ltd., of Trafford Park, Manchester, is paying a dividend of 8 per cent. for last year, the same as in 1925.

Obituary.

Mr. Arthur Henry Leech, head of Messrs. Leech, Son and Dean, mining engineers and surveyors, of Wigan, died this week at Southport at the age of seventy-one years. Mr. Leech was consulting engineer to a number of colliery companies in this part of the country.

Non-ferrous Metals.

In the non-ferrous metal market tin has maintained the steady improvement which set in towards the end of January, and has continued to do so ever since. Since last report the metal has displayed its customary sensitiveness to market influences, a bearish factor which exerted its effect at one time being the rumours of heavier stocks. Notwithstanding this, however, since last I wrote there has been a net rise of nearly £3 in spot metal, although the improvement in the forward position has been less marked. Buying, both on American and continental account, has been fairly active. Moderate purchases have also been in evidence on the copper market, and here again, in spite of reports of increased stocks of the metal at American refineries, with the usual results on market prices, the position at the time of writing shows a recovery of the loss reported a week ago. The demand for lead has shown a certain amount of improvement, but this has not been sufficient to counteract the effects of rather heavier offerings of the metal, especially from Germany. Values have eased in this section of the market, and prices are now back to where they were a month ago. There is a fair volume of buying in the case of spelter, but after showing a slight gain at the close of last week, there has been

a reaction during the past few days, and quotations are lower to the extent of about 10s. per ton compared with a week ago.

Iron.

The iron and steel markets here have, if anything, been even more depressed than previously, and this week conditions have been far from cheerful. Buying is, of course, going on in the case of pig iron, but it is certainly on a more restricted scale than normally. Users of the metal are entering the market as sparingly as possible, and are making every effort to conserve their existing stocks. As far as contract commitments are concerned, these are virtually non-existent, and operations on this market are almost entirely of a hand-to-mouth character. The result is that, although prices are maintained at the reductions reported a week ago, the tendency is still easy, and producers of some brands are competing keenly for what little business is offering. Staffordshire iron is quoted here at 90s. to 90s. 6d. per ton, including delivery, with Derbyshire makes at about 90s., Middlesbrough at 92s. 6d., Scottish at 104s., West Coast hematite at 97s., and East Coast at about 98s. A further reduction in bar iron prices is expected shortly, although there has been no actual change up to the present, compared with the quotations given here a week ago. Crown bars are being offered at £11 15s. per ton, and second quality material at £10 15s. The demand is extremely slow, and most of the Lancashire makers are only partially engaged.

Steel.

Apart from a certain amount of inquiry from constructional engineers there is not much stirring in the market for steel, buying, for the most part, being largely for urgent needs. With the exception of ship plates, which have an easy tendency at £8 7s. 6d. to £8 15s. per ton, other varieties keep fairly steady at £7 17s. 6d. to £8 for joists and sections, £11 10s. for boiler plates, £9 for basic steel bars, £12 10s. for special acid wire billets, and £11 for ordinary qualities, and about £9 10s. per ton for forging blooms. Small re-rolled bars are quiet and easier at £8 15s. per ton delivered. Continental prices are fluctuating somewhat, but the general tendency is towards slightly higher levels, with ordinary plates at £7 7s. 6d. to £7 10s., Siemens plates at £7 12s. 6d. to £7 15s., joists at about £6 5s., steel bars at £6 2s. 6d., wire rods at £6 2s. 6d. to £6 5s., sheet bars at £5 15s., and billets at £5 10s. to £5 12s. 6d. per ton. Taking this section of the market as a whole, buying of imported steels is slow, and there is not much inquiry passing at the moment. Galvanised sheets are also in quiet demand, though values are fairly steady again at about £15 5s. per ton f.o.b., for the usual Indian specifications.

BARROW-IN-FURNESS.

Hematite.

There is still the same demand for delivery of iron by consumers, but practically the whole of it has to do with orders placed some time ago. A small number of deliveries of iron on recent orders has taken place. Contracts for forward delivery are still being held up on the chance of iron becoming cheaper. The present price of iron is governed by cost of material, particularly fuel, and until there is a reduction in that commodity there seems little chance of a fall in pig iron. There seems to be a general outcry against the price of coke ruling at the present time, and the sooner it becomes cheaper the better it will be for the iron trade. Orders are expected, naturally, in view of the brighter prospects in the engineering and shipbuilding trades, but they are not coming to hand as fast as one could wish. The local deliveries of iron are going by rail and sea, and North Wales consumers are now regular customers. There have been shipments coastwise to home ports for consumption and also for transhipment to India *viâ* Liverpool. The Continent has not become an important customer as yet. The iron ore trade is keeping up and is likely to. There is a growing trade outside the district, but there is room for further expansion in this direction. The rail mills are kept going, but the orders coming to hand are not keeping up with deliveries. The small section and hoop mills are well circumstanced.

SHEFFIELD.

(*From our own Correspondent.*)

Heavy Steel Trades.

THE general position of the heavy steel trades remains much the same as for several weeks past. The question of immediate work gives no cause for worry, as the open-hearth furnaces have contracts to complete which will last six or eight weeks. Considerable anxiety, however, is felt as to what will happen when the arrears of work have been met, for very little new business is being placed. At the moment the prospects are anything but promising, and though there is still plenty of time for conditions to improve, steel makers are displaying some anxiety. One of the main obstacles to a development of trade is the question of price, and buyers are afraid to commit themselves to forward business on the terms now ruling. They are waiting to see how the market will move. The high price of blast-furnace coke, and the consequent high price of pig iron, is an important factor, and until the position in regard to these commodities becomes more normal, it is not likely that much headway towards trade recovery will be made. Several moves in the right direction, however, are apparent, and last week-end an additional battery of modern coke ovens was put into commission. Work in the rolling mills is of an irregular character. The imports of iron and steel last month were unusually heavy, being double the quantity in February last year, which shows clearly what a shortage there has been of British material. The heavy engineering departments at the Sheffield and district works are only moderately well employed. Railway engineering shops are quieter than they were, and there is general complaint about the difficulty of getting new business. This is particularly the case on the export side.

Lighter Steel Trades.

A more optimistic view can be taken of the lighter steel and engineering trades. Some firms have been busy since the beginning of the year, and report that they are satisfactorily booked up for some time ahead. This experience, however, is not general, and seems to apply in particular to those firms making special lines which command a good sale, both at home and abroad. Several new electric furnace installations have been put down in Sheffield lately, which in itself is a good sign. Certain classes of special quality steels, by the way, are threatened by the new tariff proposed by the French authorities. For example, there is one case in which the duty suggested works out, at the present rate of exchange, at more than £30 per ton as a minimum. Since the war France has developed industries to the displacement of Sheffield trade, and the necessary protective measures have naturally been taken in the French Government Bill. The matter, which, it is believed, will seriously affect several sections of Sheffield trade, is being considered by the local Chamber of Commerce. The tool trades have been in a dull state for some time, but there are signs that business is reviving. Better orders are reported by a number of firms, the articles chiefly involved being engineers' tools and files. Colliery equipment is not being particularly well bought, which is probably a result of the poor state of the coal trade locally, many of the pits having to work a short week.

Plate and Cutlery.

The plate and cutlery trades do not make much headway, and although the time of the year has arrived when a spurt should be given to the buying movement, no signs of it are yet discernible. Good class hollowware is inactive, but a good level of business is being done in cheap plated lines. Most of the activity in good quality cutlery is accounted for by contracts for catering establishments and orders from the Dominions and Colonies. Exports of cutlery last month amounted to £66,000, an increase of about £4000 on the figure for the corresponding month last year. There were drops in the exports to the United States, India and South Africa, but increases in the case of Australia, New Zealand, Canada, the Argentine, and Brazil.

Coke Oven Contract.

An order has been placed by the Monckton Coke and Chemical Company, Ltd., with Simon-Carves, Ltd., of Manchester, for a battery of twenty regenerative coke ovens to be erected at the New Monckton Collieries, near Barnsley. The ovens, which are of the latest "Underjet" type, will be built, in accordance with modern practice in this country, the United States and the Continent, of high-silica bricks, which permit of considerably higher temperatures being employed in the carbonisation process than is usual with ovens constructed of fire-clay bricks, which have until recently been generally used in this country. A great reduction in the coking time is by this means obtained, with a consequent corresponding increase in the output of coke and by-products per nuit. In addition to the battery of ovens, the Monckton Company has placed an order for an extension of its by-product plant, and for plant for the de-watering of the small coal, which is to be treated in the coke ovens subsequently to its being washed to remove mineral impurities.

Gas Industry Developments.

Another matter of interest to those in the coking and gas industries is the decision of the Sheffield Gas Company, which for some time has taken a daily supply of 5,500,000 cubic feet of coke oven gas, to enter into an agreement for another 3,500,000 cubic feet per day, under conditions which will guarantee a continuity of supply. Such an arrangement is probably the first of its kind. If this example is followed generally, it will mean a much wider use of coke oven gas for town supply, the trouble hitherto being that, having no guarantee against an interruption in the supply, gas companies, with their heavy statutory liabilities to maintain their service, have hesitated in making themselves too dependent upon the coke ovens. Sheffield's decision has evidently been made possible as a result of the lesson learned during the dispute last year. Rotherham Corporation gas undertaking is also proposing to go in for important developments affecting the coke oven industry. Application has been made to the Ministry of Health for sanction to borrow £53,479 for the purpose of the gas undertaking. The Corporation has the right to purchase coke oven gas up to 3,500,000 cubic feet per day, and its maximum at present is 1,500,000. The Gas Committee is making every endeavour to supply gas to manufacturers in large quantities, so as to deal with the surplus supply of 2,000,000 cubic feet. It hopes to be able to put before the manufacturers of the district favourable terms for large quantities of coke oven gas, which would be purified and of the same calorific value as that supplied to the ordinary consumer.

Dealing with Coal Output.

Speaking to members of the Goole Chamber of Trade, the Hon. Joseph Pease, of Pease and Partners, Ltd., referred to the proposal of his company to construct a private railway from Thorne Colliery to Goole and a coaling wharf in the Ouse. A Bill was at present before Parliament, he said, and it was desired to obtain a natural outlet for the export of coal from the Doncaster coalfields. Goole at present was dealing with just over 2,000,000 tons of coal yearly, and it was calculated that within five years accommodation would have to be found to deal with some 4,000,000 extra tons. If accommodation were not found at the river port for the 10,000,000 tons estimated to be raised from the Doncaster coalfields, the inland market would be over-supplied, and the older and more expensive pits would have to reduce their outputs, and in some cases go out of commission altogether. If the port could handle the increasing trade, the country would be in a position to attempt to regain its foreign coal market, which had been lost during the past few years.

Gift to University.

The Miners' Welfare Committee has informed the Leeds University authorities that it is prepared to make a contribution of £10,000 towards the cost of erecting a new building for the Mining Department of the University. The Committee has already done a great deal to assist the development of mining education in Yorkshire. At present the Mining Department shares with the Department of Coal, Gas and Fuel Industries a building which was erected in 1906. Owing to the growth of both departments, the building is now barely large enough for the needs of either, and the claim for a new mining building is urgent.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

The Trade Position.

WHILE the feeling of confidence which has characterised the iron and steel industry in the North of England for some time past has not departed, it cannot be denied that, with orders being executed more quickly than new contracts are being arranged, some apprehension is being felt as to the future prospects. Manufacturers can keep plant going at the present output capacity over the summer with work already secured, but some firms will be unable to run at full pressure over the fall of the year unless business expands considerably. In order to solve the fuel problem, orders for many thousands of tons of German coke have been placed during the past few days by Tees-side ironmasters. One contract alone is stated to be for 20,000 tons. Anxious to effect every possible economy in the costs of iron production, the Cleveland ironmasters have been faced by great difficulties in the cost of fuel. Durham blast-furnace coke costing round about 26s. per ton, while German coke has stood at 22s. 6d. per ton delivered.

Cleveland Iron Trade.

Business in the Cleveland pig iron trade continues on very quiet lines, but the ironmasters are in no haste to execute the price reductions which buyers contend must come sooner or later. Consumers are pronounced in their opinion that quotations are too high and that, until recognised market quotations are brought into line with their ideas of values, material expansion of transactions cannot be looked for. Producers of most commodities, on the other hand, declare that the margin of profit is extremely small, and that in some departments commodities are actually being produced at a loss. Foreign business is almost unobtainable, continental prices being so low that it is even possible to pay the freight and yet to undersell British iron in the home market. Producers are, however, not yet in urgent need of orders. Running contracts are sufficient to absorb practically the whole of the output, and they seem disinclined to cut prices until there is a corresponding decline in the costs of production. On that account everybody is closely watching the coke market, high coke prices being the crux of the ironmasters' problem. The purchase of German coke has had some effect, and there is the further fact that that supply has now evidently overtaken the demand. Cleveland pig iron prices are unchanged, No. 1 foundry being 82s. 6d.; No. 3 G.M.B., 80s.; No. 4 foundry, 79s.; and No. 4 forge, 78s. 6d., f.o.t. and f.o.b.

Hematite Pig Iron.

Makers of East Coast hematite pig iron contend that prices have already sunk below the cost of production, but the market still tends downwards. West Coast makers are competing keenly for home trade, and good continental hematite is offered at 80s. per ton f.o.b. Antwerp, which, of course, is sufficient explanation of the absence of any European demand for East Coast hematite. Nor is the home market at all active, and makers are simply doing business on the best terms available. East Coast mixed numbers are offered at 85s. per ton.

Ironmaking Materials.

A few odd cargoes of foreign ore have been sold, but that is the extent of the business done, and the position is virtually unchanged from last week, with best Rubio ore still nominally 22s. per ton c.i.f. Tees. There is an easier tendency in the coke market, but prices are irregular. Some sellers still name 26s. per ton as the delivered price of good Durham furnace coke, but, on the other hand, it is reported that there have been sales as low as 24s., and probably 25s. is almost an average market figure.

Manufactured Iron and Steel.

In the manufactured iron and steel trade producers are putting up strong resistance against customers' efforts to secure price concessions, but with business coming forward slowly, favourable consideration might be given by some firms to offers of substantial orders at a little below market rates. Old contracts are being worked off at a more rapid rate than they are being replaced, but manufacturers have a great deal of work still to execute and are reluctant to cut prices to any extent.

The Coal Trade.

There is practically no life in the Northern coal trade for prompt business, and even for definite April shipments operators find little to occupy their attention. In every description of coal, fitters have only moderate prospects so far as actual bookings foreshadow. Hence they are increasingly anxious as to the future. They declare that they are already working very near the cost margin line, and frequent lost days for want of trade are a source of apprehension as to the financial results. They assert that it is economically impossible to make any more cuts in prices. Merchants reply that it is next to impossible to secure orders at current figures, and that therefore business is falling into the hands of foreign competitors.

The Finnish State Railways' contract for 20,000 tons for April and May has been secured by a Newcastle firm of merchants, but the order has been placed for Scottish coals at 19s. to 19s. 1½d. per ton c.i.f. The price is only estimated to allow about 13s. 6d. f.o.b., which is some shillings below the present prices of Northumberland coals of similar class. Best Northumberland steam coals are holding steadily to the recent quoted range of prices, and even for the inquiries over the summer months are not showing the slightest signs of cutting the prices. Thus, any success obtainable in securing fresh orders from abroad will be thrown on the hands of the speculative merchants, as there are very definite signs that Westphalian and other competition will be desperately keen, and prices are likely to rule very low. Meantime the normal quotation for best steams is 16s. 9d. to 17s., with secondary qualities at 15s. to 15s. 6d. Steam smalls remain a dull trade, ordinary being 10s. to 10s. 3d., washed smalls 15s. 6d., and singles 16s. 6d. Business in Durham gas coals continues slow, and the production at many pits has to be curtailed. Best qualities are firmly held at 17s. 6d. to 18s., and seconds at 15s. 6d. to 16s. Durham coking unscreened and also unscreened bunkers are in good supply at 15s. 6d. for good sorts and from 16s. to 16s. 6d. for best or special classes. The market is moderately steady for all descriptions of coke, but, with supplies increasing in volume, the tendency is quiet and barely steady. Gas coke is 22s. 6d. to 23s. 6d.; patent foundry cokes, 25s. to 28s.; and beehive and special cokes, 30s. to 32s. 6d.

Concession to Ironstone Miners.

As the result of a meeting of the Joint Committee of the Cleveland Ironstone Mineowners and the Cleveland Miners' Association this week, an advance of a halfpenny per ton was granted to men employed in the south district of the Park Pit, Skelton. The men had contended that they could not make a reasonable wage under the existing tonnage rates.

Ironworks to be Dismantled.

Bolckow, Vaughan and Co., Ltd., Middlesbrough, have decided to dismantle their Clay-lane Ironworks, which have stood idle since the mid-war period. Shortly after the settlement of the coal strike, the firm gave serious consideration to the possibility of restarting the old furnaces, but it has been found that the plant cannot, in existing conditions, be operated on an economic basis. At one time the works employed more than 1500 men.

SCOTLAND.

(From our own Correspondent.)

Dull Markets.

THE general situation is without alteration. Markets remain dull and signs of improvement are lacking.

Steel.

New business remains quiet. Consumers show little interest in the market, but are taking large deliveries against contracts. Steel makers are hard pressed by shipbuilders and others, but a good few weeks must elapse before the works will slacken off, even allowing for the lack of fresh orders.

Steel Sheets.

Makers of steel sheets report satisfactory developments. Sheets of the lighter gauges are especially busy, and certain producers are fully sold some weeks ahead, both in black and galvanised varieties for home and export. Prices are steady.

Bar Iron.

The bar iron works are not busy. Demands are very moderate and neither in the iron nor re-rolled steel departments are plants engaged at anything approaching full capacity. No change in bar iron prices is reported, but re-rolled steel bars could be done somewhere under the recent quotation of £8 10s. per ton, home or export.

Pig Iron.

The number of furnaces in blast in Scotland now amounts to thirty-three. Of that number, ten are producing hematite, supplies of which are hardly large enough to meet deliveries which are pressed for against contracts. Foundry qualities, on the other hand, are in sufficient supply to cover all immediate requirements. The tendency of prices is easier.

Coal.

Very dull conditions obtain in the coal market, in which the outlook for the home or the export trade is rather discouraging. Home merchants still feel the presence of American fuel, which is extensively used by railways and gas companies, while other concerns are not taking their usual quantities, owing to the slow development in many branches of industry. So far as export is concerned, the depression is most acute. Exporters are receiving little in the way of fresh business, owing largely to very keen competition from the North of England as well as foreign fuels. Apart from a slightly better turnover in treble nuts in all districts and a certain steadiness in Lanarkshire splints, there has been practically nothing of fresh interest in the market. Aggregate shipments amounted to 244,416 tons, against 233,052 tons in the preceding week and 207,792 tons in the same week last year.

Finnish Coal Contracts.

It has been reported that the Finnish State Railways have accepted offers of Scottish coal only in connection with recent tenders for 25,000 tons of locomotive coal for April–May shipment. The price has not been disclosed.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

ON the whole, the conditions in the steam coal trade are very steady and shipments are on an active scale. The tonnage position is not all that could be desired, but at the same time it is evident that the bulk of the collieries are better placed for orders as in some instances they are unable to stem any further tonnage for loading this month and the early part of next, while in the case of other undertakings they are asking much longer loading hours than were stipulated for a week or so ago. It speaks well for Welsh coals that this should be the case, when it is remembered that competition of foreign coal producers continues to be very keen, while North Country coals are below their relative value. Many orders have been lost to this district, owing to the reduced prices at which North Country coals are obtainable, and it is surprising that more business has not been placed for them. It is understood that one of the leading home railway companies has contracted for its requirements over the remainder of this year for Scotch coals, and that the Irish railways have for the moment deferred operating, and are only buying on a hand-to-mouth principle. The Palestine Railways have purchased 10,000 tons of Welsh large coals, but it would appear that many foreign consumers are rather inclined to hold their hands, until there is some definite news forthcoming regarding the threatened strike in the bituminous coalfield of the United States. Since I wrote last week, very conflicting news has been received from America. Apparently, negotiations are still proceeding. According to some advices, some of the employers have reached a settlement, so that it is impossible to state to what extent there is likely to be a stoppage. The opinion predominates that in any event it will only be a partial stoppage, and as it is reported that the Americans have considerable stocks of coal, doubts are entertained whether the effect upon the South Wales market will be very appreciable for some little time. What may happen is that some consumers who have so far been drawing upon American coals will be disposed to look to this district for some of their requirements, owing to the possible uncertainty as to whether they will get delivery from the United States.

Improved Coal Exports.

Foreign shipments of coal for the month of February showed an improvement upon the returns for January, thus indicating a steady expansion in operations. Hopes are entertained that the figures for March will prove even better, as the total for the week ended the 18th inst. was a record for the period since the national coal stoppage. The quantity shipped amounted to over 540,000 tons, which was an advance of over 140,000 tons for the previous week. It is possible that this total will not be maintained, owing to tonnage being so uncertain in supply, but all information goes to show that exporters have a good list of orders to execute so that there is the promise of considerable activity continuing in evidence for a few weeks at any rate. Another indication of the greater activity of the collieries is the steady improvement in the demand and importation of pitwood. Just at the moment, collieries which have to buy supplies of this commodity are called upon to pay higher prices than usual. Owing to floods in France, it has not been possible to transport supplies so freely, and the result is that the quantity coming forward is somewhat restricted. The consequence is that for prompt supplies pitwood merchants are quoting and getting 37s. to 37s. 6d. per ton ex ship, these figures showing an advance of about 7s. 6d. per ton in a week.

French Duty on Tin-plates.

The text of the proposed new French import tariff shows that it is intended to place a duty of 60f. to 65f. per 100 kilos. on tin-plates and of 50f. to 55f. per 100 kilos. on galvanised sheets. These figures represent approximately an advance of 33⅓ per cent. on the present duty, and with tin-plates at their existing level will mean a duty of about £5 per ton. It is understood that in France there is a marked conflict of opinion between the French manufacturers of tin-plates and the consumers in the canning trade. The latter are making strong representations against the proposal. The present trade between France and South Wales manufacturers of tin-plates is on restricted lines, owing to the adverse state of the foreign exchange, but the new duty will make operations still more difficult.

Miners' Easter Holidays.

The Conciliation Board for the South Wales coal trade has decided that the miners shall be granted three days' holidays at Easter, viz., Easter Monday, Tuesday and Wednesday, it being understood that a colliery company and its workmen may mutually agree on any other days. The night men are to resume work on Wednesday night.

Cwm Colliery.

The Marine Colliery at Cwm, where the recent explosion took place, involving the loss of fifty-two lives, was reopened on Tuesday.

Fleet Changes Hands.

The fleet of five modern cargo boats, aggregating about 40,000 tons deadweight, belonging to Messrs. Charles Radcliffe and Co., of Cardiff, has been purchased by Haldin and Co., Ltd., of London, on behalf of the Court Line, Ltd., and the United British Steamship Co., Ltd., at a price of about £315,000.

Current Business.

The inquiry for steam coals continues to be fairly steady, except that in the case of dry qualities and inferior descriptions of large, collieries could do with prompt orders. The superior grades are all well stemmed for early loading, and are firm, best Admiralty large coals being quoted at 23s. to 24s., while best Monmouthshire Black Veins are pretty full up for the remainder of this month and the early part of next. Small coals are also quite good, and coking qualities especially are firm. In the anthracite section prices have a distinct tendency to advance, as very shortly shipments will commence to Canada, and this will mean taking very considerable supplies off the market. Patent fuel shows no alteration, but pitwood is firm at 37s. to 37s. 6d. per ton ex ship.

CONTRACTS.

LIGHT RAILWAYS, Ltd., has received an order from the Burma Railways Company, Ltd., for 100 bogie carriage underframes to suit 1 m. gauge for manufacture in Belgium by the Société Anonyme des Ateliers de Construction de Familleureux.

THE GREAT WESTERN RAILWAY has officially announced that the following contracts have been placed:—(*a*) Supply of three 2-ton petrol-electric mobile cranes—Ransomes and Rapier, Ltd., Ipswich; (*b*) provision of additional tug—Messrs. Charles Hill and Sons, Albion Dry Dock, Bristol; (*c*) overhaul of dumb hopper barges, Nos. 7 and 8, and repairs to steam hopper barge Sir Henry Mather Jackson—The Ocean Dry Docks Company, Ltd., Swansea; (*d*) overhaul of dredger David Davies—Harris Bros., Ltd., Swansea; (*e*) overhaul of ss. St. Patrick and Great Southern—Cammell Laird and Co., Ltd., Birkenhead; (*f*) overhaul of ss. Reindeer—The Cardiff Channel Dry Docks Company, Ltd., Cardiff; (*g*) repairs to caisson, Commercial Graving Dock, Cardiff—Mountstuart Dry Docks and Shearmans, Ltd., Mountstuart Dry Docks, Cardiff; (*h*) repairs to drawbridge at Swansea North Dock lock—John Lysaght, Ltd., Bristol; (*i*) reconstruction of bridge at East Dock Junction, Swansea—Mr. George Palmer, Neath; (*j*) dredging at Brentford and Chelsea—H. Covington and Sons, Ltd., Railway Wharf, Battersea, S.W. 8; (*k*) supply of electric pumps for Landore—F. Pearn and Co., Ltd., West Gorton, Manchester; (*l*) supply of pumps for Truro—Tangyes Ltd., Cornwall Works, Birmingham; (*m*) reconstruction of Paddington Goods Station (second instalment)—The Cleveland Bridge and Engineering Company, Ltd., Darlington; and (*n*) supply and erection of three 3-ton electric luggage lifts for Paddington Goods Station—Etchells, Congdon and Muir, Ltd., Mill-street, Ancoats, Manchester.

THE MACHINE TOOL TRADES' ASSOCIATION.—The annual dinner of the Machine Tool Trades' Association was held at the Trocadero Restaurant on Wednesday last, with the President of the Association, Sir Alfred Herbert, in the chair, and Viscount Wolmer, Assistant Postmaster-General, as the guest of the evening. The attendance was excellent, and amongst the guests we noticed several Labour Members of Parliament. Sir Alfred Herbert proposed the toast of "His Majesty's Ministers" in his usual happy vein, and in responding Lord Wolmer said that the Government fully recognised the injury which heavy taxation did to trade. He felt sure that the Chancellor of the Exchequer would do his best to avoid imposing further taxation which would affect the industries of the country. "Our Guests" was proposed by Mr. L. F. Massey, and to it Sir Henry Fowler and Mr. Bertram Austin replied. Mr. Robert Young gave the toast of "The Machine Tool Trades' Association." In responding to it, Mr. H. G. Williams said that whilst the machine tool industry was a key industry, the number of people it employed was remarkably small, only 25,000 in this country, and probably not more than 150,000 in the whole world. Touching upon mass production, he expressed the view that there was another side to the case than that usually put forward. He regarded it as checking progress by the rigid standardisation which it imposed. The last toast was that of "The Chairman," proposed by Mr. F. Pollard, and gracefully acknowledged by Sir Alfred.

BRITISH ELECTRICAL DEVELOPMENT ASSOCIATION.—The annual dinner of the British Electrical Development Association was held at the Savoy Hotel on Thursday, March 17th, when the President, Sir James Devonshire, presided. In proposing the toast of "Co-operative Publicity," Dr. Ferranti referred to the importance of advertising electricity in a general way and of bringing its advantages to the notice of the public. Co-operative advertising was just as important as individual advertising, because it created a general demand for electrical goods. The Right Hon. Charles A. McCurdy also referred, in replying to the toast, to the great need for educating the public in the uses of electricity by co-operative advertising. "The Public Service of Electricity" was proposed by Sir Henry Fowler, and in reply Alderman W. Walker, of the Central Electricity Board, remarked that the increased use of electricity in the home was having a very marked effect on the industry throughout the country. If the results of the Electricity (Supply) Act were not to reduce the average price of electricity to less than it was to-day, then it would have proved a failure. Mr. W. B. Woodhouse, of the Yorkshire Electric Power Company, also replied, and Sir James Devonshire proposed the toast of "Our Guests." The British Electrical Development Association has now been in existence for nearly eight years, and there is no doubt whatever that it has done extremely useful work. During the past few months exhibition electric houses have been organised in all parts of the country, and no fewer than 1,500,000 people are said to have visited them.

RESEARCH AND THE METAL INDUSTRIES.—An exhibition which has been arranged and opened to the public at the Science Museum, South Kensington, affords some indication of the assistance given to British metal industries by the research and auxiliary services of an industrial research organisation. The exhibit is that of the British Non-Ferrous Metals Research Association, which, with the co-operation of the industry through membership of the Association, carries on a two-fold service, first, in the prosecution of research work either of a fundamental and scientific character or of direct practical utility; and, secondly, in maintaining a highly organised information service which operates for the general benefit of the Association as a whole, and to meet the specific needs of individual member firms. The present exhibit is concerned chiefly with eight of the Association's researches, chosen from among eighteen major investigations at present in progress. Those selected are typical of the character and wide range of the work which is being carried out, and the exhibits have been set out to give some idea of the scope of each piece of work and the progress which has so far been made. Some indication of the range of work can be gathered from the subjects chosen for exhibition, which are as follows:—Effect of impurities up to 1 per cent. on the properties of copper; brass casting: the surface and internal soundness of ingots; die-casting alloys: Section I., brass and bronze alloys; Section II., aluminium alloys; spectroscopic assay of zinc; gases in copper castings; the jointing of metals; "wiped" plumbers' joints; atmospheric corrosion. There is also shown one case which gives information in regard to the Association's administrative, library and information services, with some examples of the work normally carried out in these departments. The exhibition is open to the public daily, and literature descriptive of the material on view and of the other work being carried out by the Association may be obtained at the Science Museum, or from the secretary, B.N.F.M.R.A., 71, Temple-row, Birmingham.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/–
(1) Spanish	18/6 to 21/–
(1) N. African	18/6 to 21/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	22/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 5 0 to 4 7 6	
No. 1 Foundry	4 12 0 to 4 15 0	
No. 3 Foundry	4 7 6 to 4 10 0	
N.E. COAST—		
Hematite Mixed Nos.	4 5 0	4 5 0
No. 1	4 5 6	4 5 6
Cleveland—		
No. 1	4 2 6	4 2 6
Silicious Iron	4 2 6	4 2 6
No. 3 G.M.B.	4 0 0	4 0 0
No. 4 Foundry	3 19 0	3 19 0
No. 4 Forge	3 18 6	3 18 6
Mottled	3 17 6	3 17 6
White	3 17 6	3 17 6
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	4 0 0	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	4 0 0	–
Foundry Forge	3 13 0	—
(3) Derbyshire—		
No. 3 Foundry	4 2 6	–
Forge	3 18 0	—
(3) Lincolnshire—		
No. 3 Foundry	4 1 6	—
No. 4 Forge	—	—
Basic	4 0 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 17 6 (a); 5 0 6 (b); 5 4 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 5 0	—
Best	—	—
N.E. COAST—		
Iron Rivets	12 15 0	—
Common Bars	11 15 0	—
Best Bars	12 5 0	—
LANCS.—		
Crown Bars	11 15 0	—
Second Quality Bars	10 15 0	—
Hoops	14 0 0	—
S. YORKS.—		
Crown Bars	11 15 0	—
Best Bars	12 5 0	—
Hoops	14 0 0	—
MIDLANDS—		
Crown Bars	11 10 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 10 0	—
Gas Tube Strip	12 15 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	11 0 0
Ship Plates, ¼in. and up	8 7 6 .. £8 0 0 to 8 5 0	
Sections	7 17 6 .. £7 10 0 to 7 15 0	
Steel Sheets, under 9/16 in. to ¼in.	10 0 0 to 12 0 0	
Sheets (Gal. Cor. 24 B.G.)	— £15 7 6 to 16 0 0	

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 10 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 12 6	—
Soft Billets	7 12 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0†	—
Light Rails	8 15 0 to 9 0 0	
Billets	8 0 0 to 11 10 0†	
MANCHESTER—		
Bars (Round)	9 0 0	—
,, (Small Round)	8 15 0	—
Hoops (Baling)	11 0 0	11 0 0
,, (Soft Steel)	10 15 0	10 15 0
Plates	8 15 0	—
,, (Lancs. Boiler)	11 10 0	—
SHEFFIELD—		
Siemens Acid Billets	11 0 0	—
Hard Basic	9 2 6	—
Intermediate Basic	8 12 6	—
Soft Basic	7 15 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 5 0	—
MIDLANDS—		
Small Rolled Bars	8 15 0 to 9 0 0	
Billets and Sheet Bars	7 0 0 to 7 5 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	15 0 0 to 15 2 6	
Angles	7 17 6 to 8 0 0	
Joists	7 17 6 to 8 0 0	
Tees	9 0 0	—
Bridge and Tank Plates	8 17 6 to 9 2 6	
Boiler Plates	11 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	19/9 to 20/3
Block Tin (cash)	315 10 0
,, (three months)	300 5 0
Copper (cash)	56 2 6
,, (three months)	56 12 6
Spanish Lead (cash)	27 10 0
,, (three months)	27 18 9
Spelter (cash)	30 18 9
,, (three months)	30 16 3
MANCHESTER—	
Copper, Best Selected Ingots	62 0 0
,, Electrolytic	63 2 6
,, Strong Sheets	86 0 0
,, Tubes (Basis Price) lb.	0 1 0½
Brass Tubes (Basis Price) lb.	0 0 11½
,, Condenser lb.	0 1 1½
Lead, English	29 5 0
,, Foreign	28 2 6
Spelter	31 0 0
Aluminium (per ton)	£107

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£22 10 0	7/3
,, ,, 8 p.c. to 10 p.c. ,,	£22 7 6	6/6
,, ,, Specially Refined		
,, ,,Max. 2 p.c. carbon	£36 2 6	11/6
,, ,, ,, 1 p.c. ,, ,,	£42 5 0	15/–
,, ,, ,, 0.70 p.c. carbon	£54 0 0	17/6
,, ,, ,, carbon free	1/5d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£16 for home, £16 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 12 6 scale 5/– per unit	
,, ,, 75 p.c.	£18 10 0 scale 6/– per unit	
,, Vanadium	14/9 per lb.	
,, Molybdenum	5/3 per lb.	
,, Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	9/3 per lb.	

FUELS.

SCOTLAND.

(Prices not stable.)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/9
,, ,, Ell	15/6
,, ,, Splint	15/9 to 17/6
,, ,, Trebles	14/3
,, ,, Doubles	15/–
,, ,, Singles	13/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/–
,, ,, Jewel	17/6
,, ,, Trebles	16/–
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	13/9 to 15/6
Screened Navigation	22/–
Trebles	14/6
Doubles	15/–
Singles	13/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	13/6
Secondary Steam	13/–
Trebles	14/–
Doubles	13/9
Singles	13/– to 13/6

ENGLAND.

	Inland.	Export.
(8) N.W. COAST—		
Steams		27/6
Household		42/6 to 56/6
Coke		32/–
NORTHUMBERLAND—		
Best Steams		17/–
Second Steams		15/– to 15/6
Steam Smalls		10/3
Unscreened		15/6
Household		23/– to 30/–
DURHAM—		
Best Gas		16/6 to 17/6
Second		15/6 to 16/–
Household		23/– to 30/–
Foundry Coke		26/6 to 27/6
SHEFFIELD—		
Best Hand-picked Branch	38/–	
Best Selected House Coal	30/– to 32/–	—
Barnsley Best Silkstone	30/– to 32/–	—
Derbyshire Best Brights	30/– to 32/–	—
,, ,, House	28/– to 30/–	—
,, ,, Large Nuts	26/– to 28/–	—
,, ,, Small	18/– to 21/–	—
Yorkshire Hards	19/– to 21/–	—
Derbyshire Hards	19/– to 21/–	—
Rough Slacks	11/– to 12/–	—
Nutty Slacks	8/– to 9/–	—
Smalls	3/– to 5/6	—
Blast-furnace Coke (Inland)	20/– to 25/– at ovens.*	
,, ,, (Export)	f.o.b.	27/6

CARDIFF— (9) SOUTH WALES.

Steam Coals :	
Best Smokeless Large	23/– to 24/–
Second ,, ,,	22/6 to 23/–
Best Dry Large	21/6 to 22/–
Ordinary Dry Large	20/– to 21/–
Best Black Vein Large	22/– to 22/6
Western Valley Large	21/6 to 21/9
Best Eastern Valley Large	20/6 to 21/6
Ordinary ,, ,,	20/– to 20/6
Best Steam Smalls	14/6 to 15/6
Ordinary Smalls	13/– to 14/–
Washed Nuts	18/– to 22/6
No. 3 Rhondda Large	26/6 to 27/–
,, ,, Smalls	17/– to 17/6
No. 2 ,, Large	20/6 to 21/6
,, ,, Through	18/– to 19/–
,, ,, Smalls	13/– to 14/–
Foundry Coke (export)	40/– to 47/6
Furnace Coke (export)	27/– to 29/–
Patent Fuel	26/– to 27/–
Pitwood (ex ship)	37/– to 37/6
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	37/6 to 40/–
Seconds	32/6 to 35/–
Red Vein	28/– to 30/–
Machine-made Cobbles	42/6 to 47/6
Nuts	45/– to 50/–
Beans	42/6 to 45/–
Peas	22/– to 24/–
Breaker Duff	8/6 to 9/3
Rubbly Culm	13/– to 14/–
Steam Coals :	
Large	22/– to 22/6
Seconds	20/6 to 21/6
Smalls	13/– to 14/–
Cargo Through	17/– to 18/–

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayreshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/– extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. † Latest quotations available.

(a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. * Open market price. Special price for pig iron producers, 19/– per ton at ovens.

French Engineering Notes.

(*From our Correspondent in Paris.*)

Unemployment.

In a country where the labour supply is so much below the demand that it is found necessary to import foreign labour, the present problem of unemployment is regarded as more serious than is really the case. Officially there are about 80,000 men and women out of work, and, in reality, the number is much greater; but even admitting somewhat exaggerated estimates, the proportion of unemployed is extremely small when compared with the experience of other countries during a period of monetary stabilisation. During the past week there has even been a decrease, owing to a greater activity which may be attributed more to the action of the Government in encouraging the distribution of work by the different administrations than to any general improvement in trade. For the moment there are no signs of such improvement, although it is argued that the latest returns of foreign trade show that the situation must be better than is generally represented, and the best that can be said is that there is a prevailing idea of a probable recovery in the spring. The only element of activity is provided by the distribution of orders for rolling stock to the value of something like 500,000,000 francs. More men have been taken on, which explains the decline in the unemployment figures, but as only French hands are accepted, the burden of the crisis falls more heavily upon the foreign labour.

The Coal Situation.

Seeing that it is no longer possible to maintain the present wages level, colliers accept the principle of a reduction, and they are manœuvring to make their sacrifice as small as possible. The movement began in the Saar, where the French administration gave the signal for a reduction in coal prices as a means of aiding the manufacturing industries to bring down their production costs and tide over the present crisis. That reduction is insufficient, and a further cut in prices is necessary to meet the needs of industrial consumers. Prices, however, cannot be again lowered without a reduction in wages, and the miners eventually compromised for a reduction of 8·5 per cent. In the Loire the same thing has happened, and the men are disposed to accept a 7·5 per cent. drop in wages for fear of finding themselves put on short shifts or of losing their work altogether. The coalowners have made it clear that, in view of the specially reduced freights on coal from the Saar to the Loire, it is quite impossible to maintain prices, and stocks at the Loire pits are rapidly accumulating. The miners are being made to see that the only way to save the situation is to supply cheap coal to manufacturers so that all branches of industry may recover and bring down living costs, when the purchasing value of the wages received will be higher than it was before the reduction. In the Nord and the Pas de Calais, also, negotiations are being carried out for a cut in wages. At the same time, efforts are being made to restrict the importation of British coal, first by the proposed 5 per cent. *ad valorem* duty on anthracite, which is arousing strong protests from the Chambers of Commerce of Rouen and Nantes and other ports. Of the 650,000 tons of anthracite consumed annually in the department of the Seine 400,000 tons are said to be Welsh anthracite passing through Rouen. It is claimed that the duty would be prohibitive and would cause serious prejudice to the ports which rely largely for their traffic upon the coal trade. For the same reason the ports are objecting to the low preferential railway rates for the carriage of coal from the collieries in the Nord and Pas de Calais to Rouen, with the idea of enabling French coalowners to compete with the British in the western ports. It is claimed that that would entail a sacrifice upon the railways and would only benefit the coalowners, while the ports would run the risk of losing a good deal of their traffic. As the interests of the ports are identical with those of British coalowners, it is hoped that the matter will be satisfactorily adjusted.

Colonial Exhibition.

Preparations have been started for the organisation of an international colonial exhibition which is to be held in Paris in 1929. At first it was intended to cover a vast area to the west of the city and make it by far the most important exhibition organised in this country since the Universal Exhibition of 1900; but, as that would have encroached upon the Bois de Boulogne and have caused considerable inconvenience, it was decided to relegate the colonial exhibition to the Bois de Vincennes, where the situation will render necessary an extension of the Metropolitan and other transport services in order to deal with the traffic. The railway between the Bastille and Vincennes will be brought within the Metropolitan system. It is also intended to lay down a circular railway in the grounds similar to that at the Wembley Exhibition. The necessity of developing the colonial resources to the fullest possible extent is regarded as so urgent that exceptional importance will be given to the colonial exhibition, which should mark the beginning of a great international co-operation, particularly in the opening up of the African territories belonging to France, Belgium and Great Britain.

Port of Strasburg.

Since Strasburg was made an autonomous port, and the Chamber of Commerce was invested with the powers necessary to carry out the extensions and make it a rival of the port of Kehl, on the opposite bank of the Rhine, the work has progressed rapidly and the dock for the oil traffic is now practically completed. It has an area of 50 acres, and in its construction about 16,000,000 cubic feet were excavated. An armoured concrete bridge, with a span of 102ft., has been erected over the entrance to the dock, and it now remains to complete the steel bridge with a 250ft. span and the reconstruction of the Strasburg-Kehl Railway, which is likely to prove a somewhat difficult undertaking.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

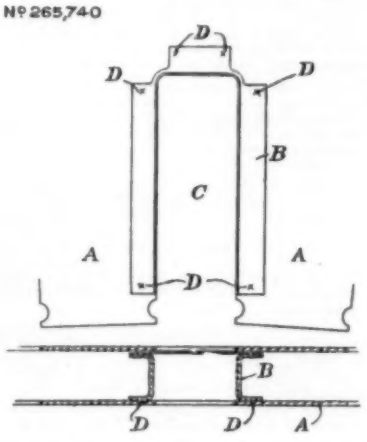
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

265,740. December 17th, 1925.—IMPROVEMENTS RELATING TO DYNAMO-ELECTRIC MACHINES, Jan Arthur Kurser, of "Knowle Lodge," Sibson-road, Sale, Chester, and Metropolitan-Vickers Electrical Company, Ltd., of 4, Central-buildings, Westminster.

In electrical machines there is a tendency for the insulation surrounding the conductors to swell when the windings get hot, and although for the most part this tendency is restricted by the walls of the slots, where ventilating ducts are provided, the slots are discontinuous and the insulation may expand into the ventilating ducts. The specification describes an improved method of overcoming these difficulties, which consists in making the wall of each slot substantially continuous from end to end of the core or a section of it, without, however, bridging the laminæ other

Nº 265,740



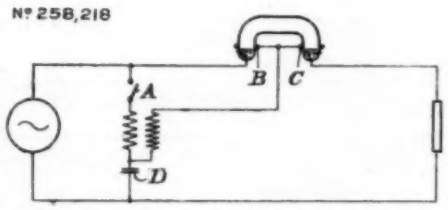
than that from side to side of each ventilating duct or passage. This is done by continuing the slots across the ventilating ducts by means of plates or bridge pieces, which may, for instance, be secured by spot welding to the lamina or core plate—referred to as a vent plate—on one or both sides of the ventilating duct or passage. The vent plate A is a punching similar in configuration to the laminæ of the core, but generally of stouter material, and the bridge piece B consists of a piece of channel section steel, which is bent round to conform to the shape of the slot C, the flanges being cut away at the corners. The bridge piece B is spot-welded to the vent plate A at the points D, and the vent plate A with its bridge piece B is assembled next to a plain vent plate composed of stouter material than the laminæ of the coil. —*February 17th*, 1927.

SWITCHGEAR.

258,218. March 29th, 1926.—IMPROVEMENTS IN OR RELATING TO METALLIC VAPOUR TUBES FUNCTIONING AS SWITCHES FOR ALTERNATING CURRENT, Siemens and Halske Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This specification describes a switch system for alternating current, characterised by the fact that during each period of the alternating current a metallic vapour tube is ignited at least

Nº 258,218



twice and a discharge is produced which is negative. When the switch A is closed, a voltage is established at the ignition poles B and C, and by suitable selection of the poles of the transformer and adjustment of the phase by means of the condenser D an arc is produced. Upon the expiration of one-half period the arc is extinguished, but it is again produced at the other electrode. An alternative scheme is also described.—*February 10th*, 1927.

TELEGRAPHS AND TELEPHONES.

258,232. July 28th, 1926.—IMPROVEMENTS IN OR RELATING TO LOADING COILS, Siemens and Halske Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

The shells hitherto used for loading coils were frequently so constructed that the coils or the coil columns were mounted upon continuous axes—say, screw spindles, for example—and inserted in a pot-shaped shell. This arrangement has the drawback that, should one or more coils become defective, they cannot be exchanged singly, but the entire coil column has to be first removed from the shell containing it, whereby a separation of the entire coil column from the cable is rendered necessary. Even after removal of the coil column a defective coil can still not be removed straight away, as before doing so all the coils situated on the same axis above the coil to be exchanged must also be removed from the axis. According to the invention, this drawback is obviated and a coil shell, more especially suitable for practical use, is created owing to the fact that the coils are rigidly suspended from the lid. The connecting cables A are introduced through holes in the lid into the interior of the casing. Below the lid the cables are divided up into individual stems B which are spliced together with the intermediate cables C coming from the coils D. The coils are fastened, for example, by means of screws, to the longitudinal bars E preferably in

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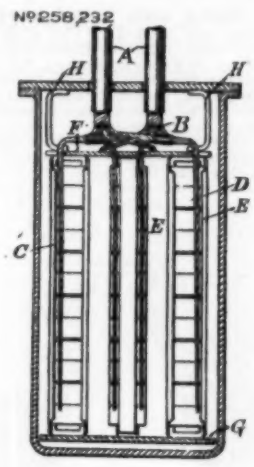

such a way that each one can be removed. By means of the plates F and G and of the bars E all the coil columns are combined to form one rigid system suspended from the lid by brackets H. Another form of construction is also described.—*February 10th*, 1927.

258,257. September 3rd, 1926.—IMPROVEMENTS IN OR RELATING TO OSCILLATION GENERATORS AND THE LIKE, Telefunken Gesellschaft für drahtlose Telegraphie, m.b.H., 9, Tempelhofer Ufer, Berlin, Germany.

The essence of this invention consists in the application of a relatively high-positive potential to the grid of a back-coupled valve so that a more gentle establishment of oscillations or reduction of damping is produced. The valve is connected with

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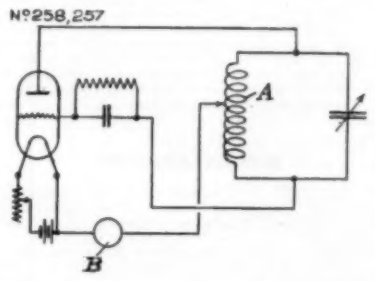

an oscillation circuit A so that the oscillation circuit lies between the anode and grid of the valve and a branch connection is led from the oscillation circuit to the cathode as shown, this being the so-called voltage distribution circuit. The source of anode potential is not, however, situated in the line between the anode and the oscillation circuit, but in the lower line between the cathode and oscillation circuit, B being the source of potential determining the anode and grid voltage. This source may be either a direct or alternating-current one.—*February 10th*, 1927.

PUMPING AND BLOWING MACHINERY.

265,275. November 2nd 1925.—IMPROVEMENTS IN OR RELATING TO VALVES FOR RAM PUMPS, Hathorn, Davey and Co., Ltd., and Hugh Ralph Lupton, both of Sun Foundry, Dewsbury-road, Leeds.

The chief object of this invention is to provide a power-saving delivery valve which is applicable to any type of ram pump. The upper end of the delivery valve spindle A is provided with a shoulder or collar B adapted to be engaged at times by a claw C on the lower end of the spindle D passing through a gland in the valve cover. The spindle D is loaded with a spring H, which

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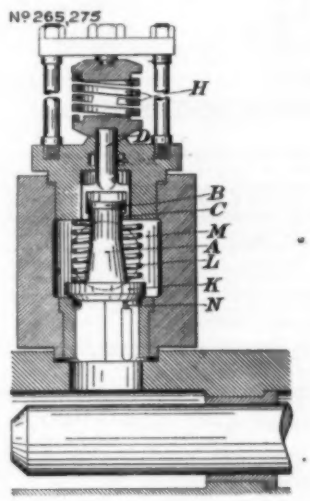


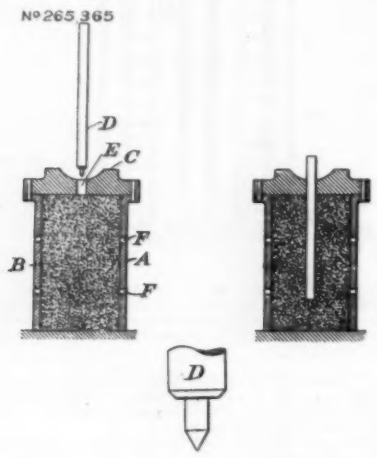
approximately balances the hydraulic pressure on the area of the spindle D during the normal action of the pump, thus ensuring that the claw member C is normally retained in the down position so as to permit the delivery spindle A to work freely up and down. The delivery valve K is provided with a light loading spring L, and when the pressure in the delivery chamber M exceeds that of the loading spring H the spindle D

with its claw member C is raised so as to cause the latter to engage the shoulder B and thereby lift and retain the valve K off its seating N until the normal working pressure is again restored.—*February 2nd*, 1927.

MACHINE TOOLS AND SHOP APPLIANCES.

265,365. January 26th, 1926.—IMPROVEMENTS RELATING TO THE PRODUCTION OF FOUNDRY MOULDS, The British Piston Ring Company, Ltd., of Holbrook-lane, Coventry; William Arthur Oubridge, of "Haldon," Park-road, Coventry; and Walter Bates, of 19, Durbar-avenue, Foleshill, Coventry.

In the making of moulds for rods or bars of circular cross section the inventors employ a box, flask or container A, into which sand B is lightly rammed. Subsequently a cover C is placed over the upper end and a metal or other pattern D is then driven through the aperture E. The cover also serves the

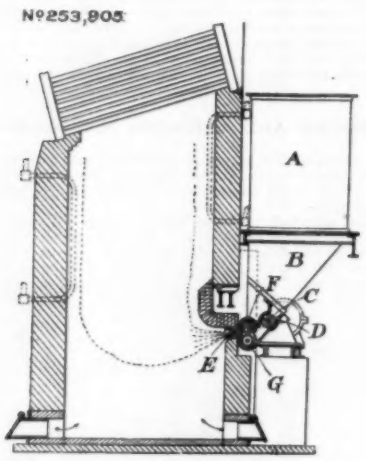


same purpose as a stripping plate in the usual methods of moulding now employed and prevents injury to the mould when the pattern is withdrawn. If desired, a number of patterns may be driven into the sand, and to facilitate driving the forward end of the pattern may be pointed or rounded. Perforations F in the side of the container allow the escape of vapour or air, which passes laterally through the sand whilst the metal is being poured. After the removal of the patterns a cover may be made to take the place of the guide so as to facilitate pouring the metal, or the cover plate C may be suitably shaped as shown.—*February 10th*, 1927.

MISCELLANEOUS.

253,905. June 14th, 1926.—IMPROVEMENTS RELATING TO THE FEEDING OF PULVERISED FUEL TO A COMBUSTION CHAMBER, Wilfred Rothery Wood, of Aldwych House, Aldwych, London, W.C. 2.

This invention comprises a method of feeding pulverised fuel, accompanied by a minimum quantity of air, to a combustion chamber. The apparatus comprises two drums rotating in opposite directions on parallel axes contained in a substantially vertical plane and spaced apart to permit of passage of the fuel between them, but otherwise close together. A is a bunker for



the pulverised coal having a discharge hopper B provided with a star feeder C or other feeding mechanism, the speed of which may be controlled in accordance with the rate of firing. This star feeder is placed in a discharge throat D which terminates in a nozzle E. Immediately in advance of the nozzle are two oppositely rotating drums F and G, which are spaced far enough apart to deliver a thin sheet through the nozzle in a substantially horizontal direction. The drums act to project a continuous stream of fuel, and clogging in the throat, particularly in the bottom, is prevented by virtue of the direction of rotation of the lower drum.—*February 10th*, 1927.

THE OLDEST ENGINEERING FIRM—The interesting question has arisen as to which engineering firm has been longest established at one address. We understand that Rose, Downs and Thompson, Ltd., have been at the Old Foundry, Hull, for no less than 150 years, and we shall be interested to know if that is a record. Richard Garrett and Sons, of Leiston, run the record close, having been established in 1778.

TECHNICAL TEACHERS.—The annual Conference of Teachers in Technical Institutions will be held this year at Plymouth, from Friday, June 3rd, to Tuesday, June 7th. The provisional programme includes, in addition to the business of the Conference, a number of visits. Arrangements are being made to visit, amongst other places, H.M. dockyard, to view vessels under construction and in commission. Moorland and sea excursions are being organised, and an important feature will be an educational and industrial exhibition in the Guildhall, from June 4th to 10th inclusive.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Annual dinner. 7 for 7.30 p.m

INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "Electricity in the Works Laboratory," by Mr. R. E. Snoxell. 6.15 p.m.

INSTITUTION OF ENGINEERING INSPECTION.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Educative Influence of Aircraft Inspection," by Major H. Myers. 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—College of Technology, Sackville-street, Manchester. Paper, "The Exhaust Injector," by Mr. J. C. Metcalfe. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Joint meeting with the Society of Chemical Industry. "Lubrication," by Dr. W. R. Ormandy. 5.15 p.m. (Change of hour).

INSTITUTION OF MECHANICAL ENGINEERS.—Comedy Restaurant, Panton-street, London, W. 1. Annual dinner of the Graduates' Section. 7.15 for 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W 1. Lecture, "Notes on the Construction and Plant of the New Filtered Water Installation for the Seville Waterworks Company," by Mr. S. R. Broderick. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Literary and Philosophical Society's Lecture Theatre, Newcastle-upon-Tyne. "Pure Science: the Service it has Already Rendered to Engineering and a Review of Modern Developments and their Possible Future Application," by Sir Richard Glazebrook. 6 p.m.

PHYSICAL SOCIETY.—Imperial College of Science, South Kensington, London, S.W. 7. "Acoustical Experiments with a Mechanical Vibrator," by Dr. E. Mallett; "The Stationary Wave Method of Measuring Sound Absorption at Normal Incidence," by Dr. E. T. Paris; "A Ball and Tube Flowmeter Suitable for Pressure Circuits," by Mr. J. H. Awbery and Dr. Ezer Griffiths; a demonstration of the astrolabe and some other mediæval surveying and navigational instruments will be given by Dr. Allan Ferguson. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Thunderclouds," by Professor C. T.R. Wilson. 9 p.m.

SATURDAY, MARCH 26TH.

BOROUGH POLYTECHNIC INSTITUTE.—Borough-road, London, S.E. 1. Annual Exhibition of Students' Work. 2.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Students' afternoon visit to the works in progress at West India and Millwall Docks.

INSTITUTION OF MECHANICAL ENGINEERS.—Graduates' Section visit to the Port of London Authority's Royal Victoria, Albert and King George V. Docks. 10.30 a.m. Western entrance to the Victoria Dock.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Westoe-road, South Shields. North-Eastern District meeting. 2.15 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—The Guildhall, Rochester. South-Eastern District meeting. 11 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South Midland District meeting at Leighton Buzzard, Beds. 11 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Manchester. Joint meeting of the Yorkshire and North-Western Districts. Discussion, "Manchester and District Joint Town Planning Report," opened by Mr. R. Bruce. 2.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Alpha Rays and Atomic Structure," by Sir Ernest Rutherford. 3 p.m.

MONDAY, MARCH 28TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Graduates' Section meeting. Annual lecture, "Torpedo Boats and their Machinery," by Sir J. E. Thornycroft. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lecture, "Some Industrial Applications of Electrothermics," by Mr. G. I. Finch. 8 p.m.

TUESDAY, MARCH 29TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "Some Properties of Coke," by Professor J. W. Cobb. 5.15 p.m.

SHEFFIELD METALLURGICAL CLUB.—198, West-street, Sheffield. Paper, "The Heat Treatment of Large Forgings," by Mr. C. W. Hurst. 7.30 p.m.

WEDNESDAY, MARCH 30TH.

FARADAY SOCIETY.—Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. Second Experimental Report to the Atmospheric Corrosion Research Committee of the British Non-ferrous Metals Research Association, by Dr. W. H. J. Vernon. 3 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Students' Meeting. Paper, "The London County Council Becontree Housing Estate," by Mr. V. F. Cornish. 6.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—The University, Edmund-street, Birmingham. Paper, "The Stability of Large Power Systems," by Mr. F. H. Clough. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Visit to the works of the Park Gate Iron and Steel Company, Ltd., Rotherham. 2 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Council House, Birmingham. West Midland District meeting. Paper, "Notes on the Geology of some Rocks Used in Highway Engineering," by Mr. D. G. Bevan. 5.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Swindon. Southern District meeting. 11.30 a.m.

INSTITUTION OF PRODUCTION ENGINEERS.—Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, London, S.W. 1. Lecture, "The Development of Rustless and Allied Steels," by Dr. W. H. Hatfield. 7.30 p.m.

JOINT DELEGATION OF THE YORKSHIRE ASSOCIATIONS OF THE INSTITUTIONS OF CIVIL, MECHANICAL, ELECTRICAL, MUNICIPAL AND COUNTY, AND LOCOMOTIVE ENGINEERS.—Applied Science Department of the University, Mappin Hall, St. George's-square, Sheffield. Discussion on "Railways or Roads." 7 p.m.

LIVERPOOL ENGINEERING SOCIETY.—9, The Temple, Dale-street, Liverpool. Paper, "Properties of Steel at High Superheated Temperatures," by Dr. Andrew McCance. 6 p.m.

NEWCOMEN SOCIETY.—Prince Henry's Room, 17, Fleet-street, London, E.C. 4. Paper, "Notes on Lead Mining and Smelting in West Yorkshire," by Mr. A. Raistrick. 5.30 p.m.

THURSDAY, MARCH 31ST.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. "The Applications of Electricity in Warships," by Mr. W. McClelland. 6 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Tare and Load Compared in Modern Locomotives and Rolling Stock," by Mr. A. M. Bell. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the Brush Manufactory of Beechwood, Ltd., Chesham, Bucks. 2.45 p.m.

FRIDAY, APRIL 1ST.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Chamber of Commerce, New-street, Birmingham. Lecture, "The Testing of Heat Engines," by Mr. H. R. J. Burstall. 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Joint meeting with Chemical Engineering Group. Paper, "Lubricating Oils—Laboratory Tests in Relation to Practical Results," by Messrs. A. G. Marshall and C. H. Barton. 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "British Empire and Overseas Trade," by Major A. W. Farrer. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "Notes on the Production of Saltpetre," by Mr. G. J. Hartley. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "The Stones of London," by Mr. J. Allen Howe. 9 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—Room 24, Royal Technical College, George-street, Glasgow. Annual general meeting. 7 p.m.

SATURDAY, APRIL 2ND.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Bradford. Quarterly meeting of the Yorkshire District. 2 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Alpha Rays and Atomic Structure," by Sir Ernest Rutherford. 3 p.m.

TUESDAY, APRIL 5TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Paper, "Enlargement of the City and South London Railway Tunnels," by Messrs. I. J. Jones and G. Curry. 6 p.m.

WEDNESDAY, APRIL 6TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. "Battery Eliminators or Appliances for the Operation of Radio Receiving Apparatus by Energy Derived from Electric Supply Mains," by Messrs. P. R. Coursey and H. Andrewes. 6 p.m.

INSTITUTION OF SANITARY ENGINEERS.—Caxton Hall, Westminster, London, S.W. 1. Paper, "Kingsbury Main Drainage Scheme, 1924–1926," by Messrs. R. C. N. Newport and E. O. Danger. 6 p.m.

WEDNESDAY TO FRIDAY, APRIL 6TH TO 8TH.

INSTITUTION OF NAVAL ARCHITECTS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Annual general meeting.

FRIDAY, APRIL 8TH.

JOINT DELEGATION OF THE YORKSHIRE ASSOCIATIONS OF THE INSTITUTIONS OF CIVIL, MECHANICAL, ELECTRICAL, MUNICIPAL AND COUNTY, AND LOCOMOTIVE ENGINEERS.—Great Northern Hotel, Leeds. Second annual dinner. 6.30 for 7 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE HAMWORTHY ENGINEERING COMPANY, Ltd., of Poole, Dorset, and 79, Victoria-street, Westminster, S.W. 1, asks us to announce that it has opened a branch office at 50, Grainger-street, Newcastle-on-Tyne.

PHILIP CHAPMAN AND CO., Ltd., ask us to announce that they have moved their offices from 5, Copthall-buildings, Copthall-avenue, E.C. 2, to King's House, 36–37, King-street, Cheapside, London, E.C. 2. Their new telephone number is City 9013.

MR. BERTRAM C. JOY asks us to announce that he has transferred his offices from Ulster Chambers, 168, Regent-street, London, W. 1, to 55, Yale Court, Honeybourne-road, West Hampstead, N.W. 6. His new telephone number is Hampstead 8308.

TAKATA AND CO., Ltd., of Tokio, ask us to announce that they have registered their branch office in London as follows:—Takata and Co., Ltd., 282, Dashwood House, 69, Old Broad-street, London, E.C. 2, under the joint management of Mr. R. H. Webb and Mr. A. E. Danvers, who have hitherto, as Webb and Danvers, been acting as their agents.

NATIONAL COAL RESOURCES.—An important aspect of the work on fuel research undertaken by the Department of Scientific and Industrial Research is a survey and classification of the coal seams in the various mining districts by means of physical and chemical tests in the laboratory, supplemented, where desirable, by large scale tests at H.M. Fuel Research Station, East Greenwich, or elsewhere. The Fuel Research Board of the Department considers that the best way to carry out this work is by means of local committees representing the local colliery owners and managers, the local branch of the Institution of Mining Engineers, the Fuel Research Board, and the Geological Survey of Great Britain, as well as outside scientific interests. Each committee is charged with the duty of supervising the work of the physical and chemical survey in a coal mining area; and in this way the survey becomes of practical value from the commencement, since local knowledge and experience are made available, and the seams to be investigated and the general programme of work are decided by those who are able to estimate most correctly the relative importance of the problems to be solved. The seams selected undergo physical and chemical examination by local investigators appointed for the purpose, after which a final selection is made of those seams likely to justify experiments on a technical scale in order to test their suitability for particular uses or methods of treatment. Committees are actively at work in the following areas:—Lancashire and Cheshire, South Yorkshire, Nottinghamshire and Derbyshire, and North Staffordshire. Another committee is dealing with the coalfields of Scotland. A further committee has now been appointed to deal with the coalfields of Durham and Northumberland. The Durham and Northumberland Coal Owners' Associations and the North of England Institute of Mining and Mechanical Engineers are co-operating in this work.